THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR ..... Lawrence Frederick Spreng .....

TITLE OF THESIS ..... Visual Attention and Sensory-

..... Motor Set in Schizophrenics, ...

..... Psychiatric Controls and Normal .....

..... Subjects .....

DEGREE FOR WHICH THESIS WAS PRESENTED ..... Doctor of Philosophy .....

YEAR THIS DEGREE GRANTED ..... [illegible] .....

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR .... Lawrence Frederick Spreng ....

TITLE OF THESIS .... Visual Attention and Sensory-Motor Set in Schizophrenics, Psychiatric Controls and Normal Subjects ....

DEGREE FOR WHICH THESIS WAS PRESENTED .... Doctor of Philosophy ....

YEAR THIS DEGREE GRANTED .... 1975 ....

THE UNIVERSITY OF ALBERTA

VISUAL ATTENTION AND SENSORY-MOTOR SET IN SCHIZOPHRENICS, PSYCHIATRIC CONTROLS AND NORMAL SUBJECTS

by

LAWRENCE FREDERICK SPRENG ©

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

EDMONTON, ALBERTA

FALL, 1975

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled VISUAL ATTENTION AND SENSORY-MOTOR SET IN SCHIZOPHRENICS, PSYCHIATRIC CONTROLS AND NORMAL SUBJECTS submitted by LAWRENCE FREDERICK SPRENG in partial fulfilment of the requirements for the degree of Doctor of Philosophy

ABSTRACT

Selective attention to visual information and span of apprehension were studied in male schizophrenic patients, psychiatric controls, and university students. Most of the patients had not taken antipsychotic medication for over six weeks. None were considered to be under the influence of antipsychotic medication when tested. No patient had a total life psychiatric hospitalization of over three years. The selective attention task involved the recognition of one of two possible target letters embedded in a briefly exposed array of distractor consonants. The span of apprehension task required the subject to perceive and remember as many consonants as he could on each exposure. A post-stimulus recognition measure of span was used rather than having subjects recall and report the consonants perceived. Both perceptual tasks yielded measures in the same units with the same expected value for chance performance. Each subject received both tasks. The objective predictability of the onset time of the stimulus array was manipulated. It was hypothesized that schizophrenics would show less improvement in selective attention performance as the onset time of the stimuli became more predictable than would controls. This hypothesis was based on the postulation of

an impairment of the ability to synchronize the application of perceptual sets to the time of arrival of the stimulus in schizophrenia. A condition in which the subject self initiated the stimulus display was also included. The results indicated no effect of the predictability of stimulus onset and no difference with the self-initiate condition for any of the three subject groups on either selective attention or span. All three groups showed the same improvement on the selective attention task as compared to span. For both perceptual tasks schizophrenics performed significantly below the psychiatric controls who in turn had lower scores than the students. The results point to the absence of an attention-specific deficit in schizophrenia on a selective visual attention task. Defective pre-attentive processing and slowness of information processing are discussed as possible explanations for the results. On a sensory-motor synchronization task employing regular series of stimuli given to all subjects, schizophrenics responded by following each stimulus (click) with a response (tap) with a relatively long delay. The controls, however, responded in an anticipatory way by tapping slightly before each click, closely approaching the actual synchronization of responses with stimuli. The groups did not differ in the variability of error scores around their respective constant error biases. These findings point to an im-

pairment of the ability to synchronize motor behavior to external patterns of stimulation in schizophrenia. Schizophrenics have difficulty in maintaining a temporal sensory-motor set. An examination of the data did not support the hypothesis that this synchronization deficit is due to a slower rate of responding in schizophrenia. The results of the study are discussed in terms of theories of attentional deficit and information processing in schizophrenia. An extensive review of the literature is provided.

ACKNOWLEDGEMENTS

The research presented here was carried out at the Alberta Hospital, Oliver, Alberta. I am grateful to the staff for their help and support. I would especially like to thank Dr. B. Howarth, Dr. P. Flor-Henry, and Dr. L. Warneke for their assistance. The time and effort given by the patients who cooperated in this study is much appreciated. I also wish to thank the Departments of Psychology and Psychiatry at the University of Alberta for providing equipment and space for testing students.

My heart-felt gratitude is extended to Professor Thaddeus E. Weckowicz, my thesis supervisor, for his guidance and friendship during my years as a graduate student. The depth and breadth of his knowledge will always serve as an inspiration for me. My thanks are given to the members of my thesis committee for their assistance and encouragement. The members of the thesis committee were: Dr. W. Dewhurst, Dr. D. Schaeffer, Dr. K. Wilson, and Dr. C. Costello who served as external examiner.

I would also like to express my appreciation to Dr. K. Dabrowski for his friendship and wisdom. His depth of understanding and teaching has enriched my life. To

my friend, Dexter Amend, I would like to say how much his companionship has meant to me during our years together as graduate students.

My deepest appreciation is given to Helene Marshall for all of her help and consideration during the completion of the manuscript.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Reviewed and discussed in this introduction are theories and studies concerned with alterations of perceptual functioning in schizophrenic patients. For the past fifteen years one of the major themes in the schizophrenia literature has been that a primary disturbance in schizophrenia is an impairment of the ability to selectively process information, to focus attention on one set of stimulus objects while excluding irrelevant sources and types of stimulation. This concept has not only been applied to tasks explicitly requiring the subject to selectively attend within or between auditory and visual modalities. It has also been used to explain performance on sensory-motor tasks, size estimation, size constancy, and conceptual performance. In this paper research on and theories of attentional functioning in schizophrenia are reviewed. These theories and findings are then contextualized in the light of contemporary theories of selective information processing in normal human subjects. Emphasis is placed on the process of selective visual recognition. An empirical study is reported which was conducted in an attempt to explore the different aspects of the process of selective visual perception which may be altered in schizophrenia.

As pointed out by Bannister (1968) an individual may be diagnosed as a schizophrenic because he manifests some, but not necessarily all, of the defining characteristics of the class. However, certain characteristics such as formal disorder of thought are given a higher weighting by most authors than are other signs or symptoms. The existence of one or more underlying attributes common only to individuals classified as schizophrenics has yet to be demonstrated, although this is still a possibility. The disjunctiveness of the concept itself, as well as the divergent performance by schizophrenics on a multitude of psychological measures, has led to the conclusion, on the part of many authors, that the category of schizophrenia encompasses a variety of psychological alterations or disorders. On the other hand the use of this concept, as well as other diagnostic categories, is so widespread in the research literature that it is impossible to ignore. It serves as a basis for the organization of a vast amount of data regarding the performance of psychiatric patients on hundreds of different psychological tasks and experiments as pointed out by Neale and Cromwell (1970). One reaction to the concern over the presumed heterogeneity of the schizophrenic population has been to subdivide schizophrenic patients along the dimensions of acute-chronic, good-poor premorbid adjustment, and paranoid-nonparanoid features. In many studies the use of these subdivisions has yielded significant differences in psychological performance. However, in some studies schizo-

phrenics have been found to share commonalities in psychological functioning which distinguish them from control groups even though researchers have been careful to allow for the emergence of heterogeneity by subdividing patients into subcategories based on the three dimensions listed above. Another criticism of the use of the diagnostic category of schizophrenia has been the unreliability involved in the application of diagnostic criteria. Studies reviewed by Granville - Grossman (1971) give estimates of inter-observer agreement ranging from 62% to 92% for the diagnosis of schizophrenia. The 92% figure was found in a study where a structured interview, employing prepared definitions, was used (Wing, Birley, Cooper, Graham, & Isaacs, 1967). In a review of inter-observer reliability for the diagnosis of schizophrenia Zubin (1967) found an average concordance of 70% to 80%. Inter-observer agreement was considerably lower when British vs. American raters were compared. The reported levels of concordance provide a level of agreement sufficient for research purposes, if doubtful cases are not included and if the frequencies of the various schizophrenic symptoms are reported for the sample investigated. Such was the case for the study reported in this thesis. Unfortunately, most of the studies reviewed simply specified that one group of patients was diagnosed as schizophrenic without providing any information as to the symptom pictures of these patients.

The two commonly used (often jointly) schemes for the

diagnosis of schizophrenia are those of Bleuler (1950) and Schneider (1959). In 1911 E. Bleuler (1950), the originator of the term "schizophrenia", divided the symptoms and signs of schizophrenia into fundamental and accessory symptoms. Fundamental symptons were considered to be diagnostic of schizophrenia. Accessory symptoms could appear in schizophrenia but were not diagnostic of it. These two symptom types are often mistakenly called primary and secondary symptoms in various psychiatric texts. Primary and secondary symptoms were terms used by Bleuler with an etiological meaning and for a different division and set of symptoms. Bleuler believed that the fundamental symptoms appeared only in schizophrenia and that all of the fundamental symptoms occurred to some degree in every case of schizophrenia at one time or another. As fundamental simple symptoms he listed the following: disorder of association, a loss of the voluntary central determining idea which produced a loosening of the continuity of associations, stereotypes, dearth of ideas, pressure of thoughts, blocking, sudden leaps in thinking, condensation, symbolism, and apraxic-like phenomena; disorders of affect, extreme flattening of incongruity of affect; and ambivalence, affective ambivalence, ambitendency, and counterthinking. As fundamental compound symptoms, believed to result from the co-ordinated activity of the simple fundamental symptoms, he listed the following: autism; disorders of attention, active attention lacking, reduced selectivity of attention,

splitting of attention, and blocking of attention; disorders of volition, weakness or loss of volition, lack of tenacity and unity of volition; ego disintegration; dementia; and disorders of activity and behavior, lack of initiative, avoids work, irritability, stubborness, incomprehensible behavior, acts as though others didn't exist. The fundamental disorders of association, affect, ambivalence and autism are the four most commonly used Bleulerian symptoms of schizophrenia. One of the main themes running through the various fundamental symptoms is the impairment of the ability to decisively direct and hierarchically integrate psychological activity in a voluntary way. This can be seen in the areas of cognitive functioning (disorder of association and counterthinking), emotional functioning (incongruent affect and affective ambivalence) in which affect does not reflect decisive behavior, overt behavioral functioning (ambitendency and disorders of volition) and perceptual functioning(disorders of attention)

The diagnostic scheme of Bleuler relies heavily on the ability of the clinician to make judgments as to the presence of absence of the various fundamental symptoms. They might better be called signs. The diagnostic scheme of K. Schneider (1959) relies exclusively on the presence of symptoms which are subjective experiences of the patient. Schneider considered symptoms of the first rank to be diagnostic of schizophrenia in the absence of coarse brain disease. Schneider's symptoms of the first rank are as

follows: hearing one's own thoughts spoken aloud as a true hallucination (gedankenlautwerden), sometimes experienced as an echo (écho de la pensée); hallucinatory voices conversing about the patient or voices giving a running commentary on the patients activities; bodily hallucinations experienced as bodily sensations known to be produced by external agencies; the experience of thought withdrawal, thought insertion or other influences on thought produced by external forces; thought broadcasting where the patient experiences his thoughts as being experienced by others, usually through mental telepathy; delusional perception which occurs when an unusual private significance is attributed to a normal perception in the absence of any sort of rational or emotional reasons; passivity experiences, the experience of an influence imposed by external forces, in the spheres of feeling ("made" feelings), drives ("made" impulses), and volition ("made" volitional acts). The theme of an impairment of the ability to decisively direct and hierarchically integrate psychological activity in a voluntary way which was proposed to run through Bleuler's fundamental symptoms arises once again in the context of Schneider's first rank symptoms. Here the schizophrenic patient experiences his thoughts, feelings, drives and actions as being controlled and directed by forces or beings outside of his own individual being. Thus, he does not experience himself to be voluntarily directing his own psychological activities. Mellor (1970) reports that in a

sample of 166 patients who were diagnosed as schizophrenic, 71.7% had first rank symptoms at present and an additional 7.2% had a history of first rank symptoms. In a sample of 173 schizophrenic patients all of whom had first rank symptoms Mellor (1970) found that thought insertion and withdrawal were significantly associated with formal thought disorder (Bleuler's disorder of association). He found that "made" affect was significantly associated with the observed disorganization of affective behavior and that "made" impulses and "made" volition were both significantly associated with motor symptoms such as ambitendency nnd other catatonic signs. These findings offer some support for the idea that many of Schneider's first rank symptoms are subjective elaborations by the patient of the observed functional disturbances used in Bleuler's system.

Early studies, using unstructured interview techniques, found that early schizophrenics typically reported being unable to focus their attention. Instead, they felt that they were being flooded by external stimulation (Chapman, 1966; McGhie & Chapman, 1961). These early schizophrenics also reported a heightening of sensory vividness, difficulty in following the speech of others, loss of control of thinking, and loss of spontaneity in movement (McGhie & Chapman, 1961). A more recent study by Freedman and Chapman (1973) used a structured interview technique with samples of schizophrenic and nonschizophrenic patients. Ten males and ten females were included in each group. Only cases on

which two independent judges, employing a rating scale, agreed as to a diagnosis of schizophrenia were included in the schizophrenic group. Nonschizophrenics included neurotics, situational problems, and personality disturbances. Patients in the two groups were matched on mean and variance for age and socioeconomic background. None of the patients had taken antipsychotic medication for 30 days. Schizophrenics, significantly more often than nonschizophrenics, reported the following subjective changes: thought blocking, mental fatigue, inability to focus attention, attribution of impaired concentration to preoccupation, visual illusions, more acute auditory perception, misidentification of people and poor speech comprehension. In contrast to the study of McGhie and Chapman (1961), Freedman and Chapman (1973) found that only one half of the schizophrenics interviewed reported the experience of having difficulty in focusing their attention, although the frequency of these reports was significantly higher than it was in the nonschizophrenic group. The difference in findings between these two studies may in part be attributable to the fact that only nine of the twenty schizophrenics in the study of Freedman and Chapman (1973) were early schizophrenics in the sense of this being their first psychiatric admission, whereas McGhie and Chapman (1961) studied only early schizophrenics. Secondly, the study of Freedman and Chapman (1973) used strict criteria for the diagnosis of schizophrenia with numerical tabulations of responses to specific

questions about subjective changes, whereas the study of McGhie and Chapman (1961) was completely impressionistic in its summary of the interview data which may have introduced a positive bias into their estimates. The interview studies reviewed provide evidence that schizophrenics do experience difficulties in directing their thinking and in focusing their attention, although this is not consistently the case for every patient.

Theories of attentional dysfunction in schizophrenia have been based on an extensive amount of evidence which has indicated that schizophrenics have difficulty in assuming a voluntary set to selectively process stimulus information. Evidence bearing on performance on attention tasks and other perceptual tasks has been emphasized in these theories rather than the subjective experience of perceptual change by the schizophrenic patients. Buss and Lang (1965) and Lang and Buss (1965) concluded, after an extensive review of the research literature on psychological functioning in schizophrenia, that a dysfunction in the ability to selectively attend and to maintain a set provided the most parsimonious approach to the explanation of psychological processes in schizophrenia. Lang and Buss (1965) reached the following conclusions:

> Schizophrenics have difficulty in focusing on relevant stimuli and excluding irrelevant stimuli, in maintaining a set over time, in shifting set when necessary, in instructing themselves and in pacing themselves, and generally in performing efficiently in Wishner's sense (1955). These difficulties are pervasive, occurring over a wide range of perceptual, motor, and

> cognitive tasks. In brief, interference theory, as a broad explanation of schizophrenic deficit, has clearly been supported by research findings and appears to be the only theory comprehensive enough to account for what is known. (p. 97)

Most notable among the theories of selective attention and perceptual organization in schizophrenia have been those of Shakow (1962, 1963), Cromwell and Dokecki (1968), McGhie (1966), Yates (1966), Venables (1964), Silverman (1964a), and Weckowicz and Blewett (1959). Shakow (1962, 1963) has proposed that schizophrenics are unable to maintain a voluntary major set, i.e. a readiness to respond to specific stimuli or configurations. Instead, schizophrenics are hypothesized to be drawn to the adoption of minor sets. Shakow (1962, 1963) characterizes the schizophrenic's cognitive-perceptual functioning as being segmentalized, schizophrenics being more affected by irrelevant inner and outer aspects of their surroundings (minor sets) when attempting to focus on the relevant aspects of the situation. He viewed disturbances of thinking as well as affective disturbances to result from this difficulty in maintaining a major voluntary set and the consequent segmentalization of functioning. Shakow (1962) further suggests that the schizophrenic's inability to maintain an integrated major set may be the result of a more general trend towards the establishment of minor sets in an indirect effort to satisfy fundamental needs. This view is similar to the theory of Jung (1960), first published in 1907, that in schizophrenia the ego complex loses its supremacy and

strong feeling-toned archetypal complexes become dissociated from one another and come to dominate the psychological functioning of the schizophrenic. Although the theory of Shakow (1962, 1963) is very general, it was born largely out of his work on reaction time in schizophrenia. These studies on reaction time and sensory-motor set establishment in schizophrenia are reviewed in a later section.

Somewhat in line with Shakow's (1962) emphasis on interference from minor sets, Cromwell and Dokecki (1968) emphasized, in their work, that schizophrenics are unable to ignore irrelevant stimuli and consequently cannot focus attention on relevant stimuli. McGhie (1966, 1972) maintained that in schizophrenics the mechanisms responsible for the control and direction of attention are disrupted which then produces manifestations of heightened distractibility and the inability to hold a major set towards relevant stimuli. The conclusions of McGhie (1966, 1972) are based in part on extensive experimental research on competing information tasks to be reviewed in that section. Yates (1966) stressed that it was the slowness of information processing, on the primary channel attended to, that lead to impaired performance on selective attention tasks by schizophrenics, rather than a primary deficit in the separation of relevant and irrelevant input. His hypothesis is discussed in the context of studies on rate of information processing and visual span of apprehension in schizophrenia. The theories of Venables (1964) and

Silverman (1964a) are concerned with differential predictions as to the narrowness of attention and field articulation for acute vs. chronic schizophrenics and for other subdivisions of schizophrenia. These theories are elaborated in sections on size constancy, size estimation, field articulation and in the theoretical summary at the end of this chapter. Weckowicz and Blewett (1959) employed a selective attentional deficit explanation of size constancy performance in schizophrenic patients. Their contributions are discussed in the section dealing with size constancy studies in schizophrenia. After a review of the research literature the major findings and the theories briefly outlined above will be summarized in the context of an exposition of contemporary models of selective attention and perceptual organization in humans.

REACTION TIME AND RELATED STUDIES

Many studies have been conducted which have compared the simple reaction times of chronic long-term schizophrenics to normal subjects using visual or auditory stimuli (Huston, Shakow, & Riggs, 1937; Rosenthal, Lawlor, Zahn, & Shakow, 1960; Tizard & Venables, 1956; Zahn, Rosenthal, & Shakow, 1961, 1963) as well as studies comparing acute short-term schizophrenics to normal controls (Huston & Singer, 1945; Rodnick & Shakow, 1940; Zahn & Rosenthal, 1965). Both male and female subjects have been tested in the studies listed above. In these studies the response

typically consists of a key release and a verbal "ready" signal is given to the subject prior to the onset of the stimulus. The time interval between the warning signal and the stimulus on each trial is called the preparatory interval (PI). All of the studies given above have demonstrated the following findings: Schizophrenics have longer reaction time (RTs) than do normal controls. Schizophrenics do not show the decrease in RT for regular series of PIs as compared to irregular series of PIs that normal controls evidence at all PI values up to about 20 sec.[1] Instead, schizophrenics only show a decrease in RT for regular preparatory intervals when the PI is short (about 2 sec for auditory stimuli and about 5 sec for visual stimuli). For longer PIs the schizophrenics either show no improvement in RT for regular PIs as compared to irregular PIs or in some studies (Huston & Singer, 1945; Rodnick & Shakow, 1940; Tizard & Venables, 1956) schizophrenics actually show shorter RTs for irregular as compared to regular series of PIs. This effect of a shift in irregular vs. regular PI differences on RT depending on whether PIs are short or long, is often called the crossover effect. These

---

[1]One exception is the study of Zahn and Rosenthal (1965). They found that acute schizophrenics profited more from regular series of PIs than did psychiatric controls. Reduced RT for regular series as compared to irregular series was maintained for longer PI values for the schizophrenics as compared to psychiatric controls.

studies also found that schizophrenics show a greater increase in RT with longer PIs than do normal controls when regular PI series are given. When irregular PI series are given, schizophrenics show a greater increase in RT with shorter PIs than do normals.

Zahn, Rosenthal, and Shakow (1963) studied the effects of the preceding preparatory interval (PPI) on simple auditory RT using series of irregular PIs. Drug-free male and female chronic schizophrenics were compared to a group of normal controls. They found for both groups that longer PPIs produced longer RTs and that shorter PPIs produced shorter RTs. They also found, as reported in earlier studies, that for both groups shorter PIs produced longer RTs with their irregular PI-series task. These effects were significantly more pronounced for the schizophrenic subjects as compared to the normal controls. They maintained that these differences between the two subject groups were attributable to those trials on which the PPI was long and the PI was short as did Zahn and Rosenthal (1965). The idea is that a long PPI induces a lack of response readiness for the next trial if the PI for that trial is short, the effect being more pronounced in schizophrenic subjects. In both studies schizophrenics showed a longer simple RT on trials in which the PPI was longer than the PI, as compared to trials on which the PPI was equal to or less than the PI, than did normal controls. A study by Nideffer, Neale, Kopfstein,and Cromwell (1971) compared acute (short-term)

and chronic (long-term) male schizophrenics to acute and chronic non-schizophrenic psychiatric controls on a simple auditory RT task using series of irregular PIs. In agreement with the studies of Zahn et al. (1963) and Zahn and Rosenthal (1965), they found that both acute and chronic schizophrenics had significantly longer RTs than did controls when the PPI was greater than the PI as compared to trials on which the PPI was equal to or less than the PI. However, this effect disappeared when the confounding effect of PI with PPI minus PI was removed by holding PI constant at 2 sec and then measuring the PPI minus PI differences. Thus, in the earlier studies trials on which the PPI was longer than the PI, were trials on which the PI was necessarily in the short part of the PI range. Nideffer et al. (1971) did find, however, that the schizophrenics gave significantly more prestimulus anticipatory error responses (releasing the key before stimulus onset) than did the psychiatric controls when the PPI was shorter than the PI. These findings indicate that the schizophrenics are distracted by PPIs on RT tasks using irregular PI series, but that this is more in the direction of anticipatory mistrials, when the PPI is shorter than the PI, than it is a matter of not being ready to respond because the PPI is longer than the PI. However, the finding of Zahn et al. (1963) and Zahn and Rosenthal (1965) that, independent of PPI minus PI differences, schizophrenics show a longer RT with longer PPIs than do controls, is not explained by

Nideffer et al. (1971). The effect of PPI was not confounded with PI effects in these studies. If the greater PPI effect for schizophrenics is not attributable to trials on which the PPI is longer than the PI, then longer PPIs must produce an effect which does not interact with PI for the trial under consideration. Also, if the greater effect of longer RTs with shorter PIs for schizophrenics, using the irregular PI procedure, is not due to the effect of longer PPIs on shorter PIs, then shorter PIs must produce an effect which does not interact with the PPI length. Whatever the nature of these PPI and PI effects, they are more pronounced for schizophrenics than for normal controls. The study of Zahn and Rosenthal (1965) compared the simple auditory RT performance of acute schizophrenics (none had been hospitalized for more than two months) to the RTs of a group of nonschizophrenic psychiatric controls (depressives, anxiety reactions, and character disorders). A set index was used which yielded a composite score. A higher score resulted with the presence of longer average RTs and also with less improvement on regular vs. irregular PI series for PIs of seven seconds or more. The acute schizophrenics were found to have significantly higher (worse) set index scores than did the psychiatric controls. However, the acute schizophrenics had much lower set index scores (better) than did a comparison group of chronic schizophrenics cited from one of their earlier studies. In line with previous studies on chronic schizophrenics, these

acute schizophrenics gave significantly slower RTs with longer PIs on the regular PI series and slower RTs with shorter PIs on the irregular PI series than did the psychatric controls. This study indicates that differences in RT response patterns between acute schizophrenics and psychiatric controls are in the same direction as are differences between chronic schizophrenics and normal controls, although the differences are larger in the later case. One exception, as noted earlier, is that in the present study of Zahn and Rosenthal (1965) schizophrenics showed a greater reduction in RT than did controls when the regular PI series was compared to the irregular series. The schizophrenics showed this improvement in RT with regular PIs for longer PI values than did controls. This means that the lower set index scores of the acute schizophrenics were due to an overall higher RT, and probably the high RT means obtained by schizophrenics for long PIs on the regular series and short PIs on the irregular series. Such high RT means at specific PI values are singled out by the index.

Shakow (1962, 1963) to a large extent based his theory of segmentalized sets in schizophrenia on the RT studies reviewed here. He proposed that schizophrenics have a slower RT than do controls because of their inability to maintain a major sensory-motor set (readiness to respond) to the stimuli presented in the various RT tasks. He views schizophrenics as not showing the improvement on RT that controls demonstrate with regular in contrast to irregular PI series,

because the schizophrenic's major set to respond in terms of the temporal predictability of the stimuli in the regular PI series is disrupted by distracting internal minor response sets. The fact that this deficit, in utilizing the temporal predictability of the stimuli for regular PI series, is most pronounced for longer PIs, is explained by assumption that longer PIs in the regular series allow more time for major set interference by minor response sets to occur. Furthermore, the greater influence of the PPI on RTs of schizophrenics for irregular PI series is viewed by Shakow (1962, 1963) as an example of interference by external minor sets produced by the PPIs, as is the greater impairing effect of short PIs.

One of the main findings that has emerged from the studies on simple RT, reviewed thus far, is that schizophrenic patients are unable to utilize the temporal predictability of regular series of preparatory intervals in such a way as to reduce RT, unlike control subjects. Instead, schizophrenics only show an RT reduction for regular PIs (unpredictable time of stimulus onset) when the PI is less than the crossover value (less than 2 sec for auditory RT, less than 5 or 6 sec for visual RT). The fact that some of the studies reviewed actually showed that schizophrenics had shorter RTs for irregular as compared to regular PI series, when the PI exceeded the crossover value, has been investigated by Bellissimo and Steffy (1972). A simple auditory RT task was used. Regular PI

series were embedded within a larger series of irregular PIs. Only process schizophrenics (poor premorbid adjustment on the Elgin Prognostic Rating Scale) showed the lack of RT reduction for regular PI series as contrasted to irregular series, when the PI was three sec or longer. Reactive schizophrenics evidenced more of an RT reduction for the PI values studied than did psychiatric controls or normals, although this difference was not statistically significant. Only the process schizophrenics showed shorter RTs for the irregular as compared to the regular PI series when the PI was greater than or equal to three sec. Furthermore, only the process schizophrenics evidenced the effect that on initial trials of regular PIs the RT was reduced, while on successive trials of the regular PI blocks there was a progressive increase in RT. The authors concluded that this inability on the part of the process schizophrenics to benefit from regular PIs may be due to a detrimental effect of response inhibition which results from the response redundancy in the regular PI blocks. Steffy and Galbraith (1974) investigated the effects of intertrial interval (two and seven sec) on the crossover effect found for process schizophrenics in the earlier study just reviewed. They found that, for process schizophrenics, the crossover effect is greater when the intertrial interval is short than when it is long.[2] These results were interpreted as indicating that

[2]A greater crossover effect refers to a greater reduction in RT with regular PIs vs. irregular PIs for PIs below the crossover point, the reverse above the crossover.

reactive and protective response inhibition are more pronounced with shorter intertrial intervals. Hence, response inhibition produces a greater impairment of RT, for regular PI series, when the intertrial interval is short. On the basis of these two studies it would seem that the inability of schizophrenics to profit from the temporal predictability of regular PI series may in part be attributable to response inhibition effects which are manifest on regular as compared to irregular PI series. This hypothesis is not incompatible with Shakow's (1962, 1963) theory of the interference of minor sets on the maintenance of a major set to respond in terms of the temporal predictability of stimulus onset, for regular PI series, on the part of schizophrenics. The study of Steffy and Galbraith (1974) may simply indicate that the minor set of response inhibition competes with the major set of responding in terms of the predictability of stimulus onset for the schizophrenic subjects, when the PI exceeds the crossover value. However, their findings do account for the fact that schizophrenics are not simply unable to improve RT performance during regular PI series. When the PI exceeds several seconds schizophrenics, as reviewed earlier, show lower RTs for irregular as contrasted with regular PI series in many studies. This shift may be the result of the effect of response inhibition for regular PI series when the PI exceeds several seconds.

The reaction time studies reviewed here have indicated

that schizophrenics are relatively unable to benefit from the temporal predictability of stimulus onset, which is present when regular PI series are given, on RT tasks as compared to psychiatric and normal controls. This impairment may in part be due to the interference of response produced inhibition for schizophrenics but not for controls. Whatever the explanation, the evidence reviewed indicates that schizophrenic patients are relatively unable to synchronize sensory-motor sets with temporally predictable external sequences of stimulation. Other studies, not employing RT tasks, have demonstrated a similar inability to maintain accurate temporal sensory-motor sets.[3] King (1962) found that chronic male and female schizophrenics (off antipsychotic medication) could not keep time to clicks presented at regular (constant) intervals ranging from 1.0 to 3.0 seconds, whereas normal controls could. King found that normals tended to slightly preceed each click with a key tap whereas the schizophrenics tended to respond after the clicks in an attempt to keep time, when mean error

---

[3]A "sensory-motor set" refers here to a readiness for responding to a stimulus or in terms of a stimulus. The expressions "accurate temporal sensory-motor set" and "sensory-motor synchronization" are used synonomously in this paper to refer to the synchronization with temporally predictable stimulus sequences of a readiness for responding to the stimulus. These two terms are also used to refer to the synchronization with temporally predictable stimulus sequences of response elicitation. In this second usage the response are synchronized with the stimuli rather than necessarily being responses triggered or produced by the stimuli that they are coincident with in time.

scores were analyzed. These differences were statistically significant for intervals of 1.5 to 2.5 seconds. A much stronger finding was that when absolute error scores (the absolute amount of temporal deviation of the key tap from the click, independent of direction) were analyzed, schizophrenics showed consistently higher error scores for all of the interval values and showed a greater increase in error as the inter-click interval increased than did normals. All subjects were allowed to listen to the clicks as long as they wished and to start tapping in time to them when they wished. Chapman and McGhie (1962) found that schizophrenics (mixed acute and chronic) were not able to turn a wheel at a regular rate when distracted by an irregular beat unlike normals and nonschizophrenic psychiatric controls. In the same study schizophrenics also had difficulty on a visual motor tracking task when a distracting auditory signal was introduced, unlike normals and psychiatric controls. This last finding was replicated in a separate study by McGhie, Chapman and Lawson (1965).

Besides the response inhibition explanation of impairment of sensory-motor synchronization in schizophrenia, another possible explanation is that schizophrenics are unable to synchronize behavior with temporally predictable external stimuli because of a primary disturbance in time estimation. Of course a synchronization deficit is possible even with perfect time estimation. With respect to time estimation accuracy in schizophrenia, Lhamon and Goldstone

(1956) found that chronic schizophrenics overestimated the subjective duration of very short time intervals more than did normal controls. Subjects had to verbally estimate which actual clock duration was equal to one second. Schizophrenics gave a clock duration which was significantly shorter than the estimate of the controls. Both groups overestimated (durations judged to be one second were actually less than one second). A method of limits procedure was used. There was no difference between the two groups in consistency of time estimation. Weinstein, Goldstone, and Boardman (1958) replicated the findings of the previous study. They also found that for normals, remote anchor effects tended to balance out immediate anchor effects in the ascending and descending series of clock durations used. On the other hand, schizophrenics were influenced only by immediate anchor effects. Webster, Goldstone, and Webb (1962) found that the differences between chronic schizophrenics and normals found in the previous studies disappeared when the method of constant stimuli was used. Their results indicated that the earlier findings were an artifact of the psychophysical procedure used, because of group differences in the influence of anchor effects. Thus, there is some doubt as to the existence of an impairment of time estimation in schizophrenia.

In summary the studies reviewed in this section have pointed to a relative deficit on the part of schizophrenics in the temporal synchronization of response readiness

(RT studies) or response elicitation (e.g. King (1962)) with temporally regular and predictable stimulus events. This finding with respect to the RT studies, as well as the finding of an average longer RT on the part of schizophrenics, was explained by Shakow (1962, 1963) as being due to the disruption of major response sets (readiness to respond) by minor sets induced by internal stimuli and by external factors, e.g. the PPI on irregular PI series. The study of Steffy and Galbraith (1974) indicates that the inability to maintain an accurate temporal sensory-motor set, for temporally predictable stimulus sequences in RT tasks, may in part be the result of the processes of protective and reactive response inhibition which they postulate to be accentuated in schizophrenics. Protective inhibition (Pavlov, 1941) refers to a defensive inhibition of central responses to stimulation (external, internal, or response-produced stimulation) in order to protect the central nervous system from overexcitation. Reactive inhibition refers to a lowering of response strength due to the accumulation of fatigue built up by the evocations of successive responses. The studies of time estimation reviewed here provide little evidence for the existence of a time estimation disturbance specific to schizophrenics which might result in impaired sensory-motor synchronization.

SIZE CONSTANCY STUDIES

Weckowicz and Blewett (1959) offered a rationale for a link between size constancy and selectivity of attention in schizophrenia. They hypothesized that if schizophrenics were deficient in the ability to selectively process information, they should show more underconstancy than controls. They proposed that in order to accurately estimate the real size of objects at far distances by comparing them to near reference objects, the subject needs to form a "real object" set which involves the selective utilization of such cues to object distance as texture gradients, spatial relationships between the target object and other objects in the field, cues given by ocular convergence, and cues given by binocular and head movement parallax; and the integration of these cues with retinal image size information. Following this rationale, to the extent that schizophrenics are unable to selectively utilize and then integrate information according to the "real object" set imposed by the size constancy instructions, they should demonstrate underconstancy in their size judgments. Venables (1964) postulated that chronic schizophrenics were abnormally highly activated and thus should have extremely narrow attention which would result in restricted cue utilization and size underconstancy. The reverse was predicted for acute schizophrenics who Venables (1964) believed had abnormally low levels of activation. Venables'(1964) hypotheses extend the work of Callaway and Thompson (1953) and Easterbrook (1959) into

the area of perception in schizophrenia. In the studies to be reviewed "real object" instructions refer to requesting the subject to estimate what he believes to be the actual size of the object. On the other hand "phenomenal" instructions refer to requesting the subject to estimate the apparent size of the object.

Weckowicz (1957), Weckowicz and Blewett (1959), and Blewett and Weckowicz (1970) found that chronic schizophrenics were significantly underconstant when compared to psychiatric controls and normals. "Real object" instructions were used. In the later two studies a higher level of size constancy was found to be positively correlated with high abstraction performace scores and with a better ability to break down gestalts on Gottschold's Figures and a letter finding test. The studies of Lovinger (1956) and Raush (1952) used phenomenal instructions and did not find a reduction in size constancy for schizophrenics as compared to control groups. Lovinger (1956) found that schizophrenics judged to have poor reality contact were significantly more underconstant than were "good contact" schizophrenics or normals. Raush (1952) found that acute paranoid schizophrenics were significantly more overconstant than acute nonparanoid schizophrenics and normals under full and reduced cue conditions. The ambiguous instructions used by Hamilton (1963) make his findings that both chronic schizophrenics and manic-depressives were more underconstant than normal and neurotic controls difficult to interpret. A

number of studies using chronic schizophrenics (Leibowitz & Pishkin, 1961; Starr, Leibowitz, & Lundy, 1968) and acute schizophrenics (Harway, 1964) have not found any difference in the size constancy performance when comparing schizophrenics to psychiatric controls and normals. All of these studies used "real object" instructions. In all three studies all groups gave nearly perfect size constancy judgments under full-cue conditions. A study by Price and Ericksen (1966) used a signal-detection type paradigm. They found that acute nonparanoid schizophrenics were less accurate in their ability to make distal matches than were acute paranoid schizophrenics and normal controls, all matched for age and education. However, the results indicated that when the acute nonparanoid schizophrenics did error, they did not error more in the direction of either underconstancy or overconstancy. A review of the studies using "real object" instructions (the set relevant to the theories of Venables (1964) and Weckowicz and Blewett (1959) indicates equivocal findings with respect to the prediction of underconstancy in chronic schizophrenics which is made by both theories. One study using acute schizophrenics (Harway, 1964) found no evidence for either overconstancy or underconstancy. A second study on acute schizophrenics by Price and Ericksen (1966) revealed poorer distal size judgment only for acute nonparanoid schizophrenics. However, they did not error in any consistent direction. These last two studies provide little support for the notion that

acute schizophrenics are underconstant of overconstant. However, the finding of lower accuracy in acute nonparanoid schizophrenics (Price & Ericksen, 1966) indicates that these schizophrenics were less efficient in the utilization of relevant cues. Considered as a whole, the studies reviewed gave equivocal support to the attentional interpretations of size constancy in schizophrenia offered by Venables (1964) and Weckowicz and Blewett (1959). Further research studies on size constancy in schizophrenia which distinguish efficiency from underconstant or overconstant error biases are needed.

SIZE ESTIMATION STUDIES

Silverman (1964a, 1964b) presents a cognitive-style model of attention in schizophrenia. He claims that schizophrenics manifest the attentional styles of scanning and field articulation at their extremes. These extremes of cognitive-style are held to serve defensive functions for schizophrenic patients and are associated with differential life history adjustment patterns as well as shifts in cognitive-style extremes as a function of adjustment to long-term hospitalization. He postulates that acute poor-premorbid adjustment schizophrenics are minimal scanners (minimal degree of eye movement) while acute good-premorbid adjustment schizophrenics are extensive scanners. The relationship is hypothesized to be reversed for chronic (long-term) good vs. poor premorbid schizophrenics. Using the "centration"

principle of Piaget (1950), Silverman infers scanning from size estimation performance. Extensive scanners supposedly underestimate size while minimal scanners overestimate size since they spend more time attending to the object. Silverman also predicts that paranoid schizophrenics are extensive scanners (underestimate size) while nonparanoid schizophrenics are minimal scanners (overestimate size). Silverman's hypotheses are supported in studies by Harris (1957), Zahn (1959) and Silverman (1964b). However, studies by Davis, Cromwell and Held (1967) and Neale and Cromwell (1968) indicate that differences between acute good versus acute poor premorbid schizophrenics and between paranoid versus nonparanoid schizophrenics, as postulated by Silverman above, are a function of error biases not accuracy.[4] Furthermore they are not a function of scanning in the sense of eye movements since acute nonparanoid poor premorbid schizophrenics gave overestimation error biases and acute paranoid good premorbid schizophrenics gave underestimation error biases when the stimuli were presented at 100 msec exposures. In line with these results Silverman and Gardner (1967) found a significant positive correlation between

---

[4]Accuracy refers to the absolute difference between the subject's size estimations and the true size of the object independent of the direction of the error. On the other hand, error bias refers to the extent to which a subject tends to error in one direction or another, i.e. the extent to which his inaccuracy is biased towards under or over estimations of size.

degree of eye movement and magnitude of size estimation in acute and chronic schizophrenics rather than the expected negative correlation which was, however, found in normals. Lastly, McKinnon and Singer (1969) found no significant correlation between eye movement and size estimation in acute schizophrenics when corneal photography was used. In conclusion the central hypotheses of Silverman (1964a, 1964b) are not supported by the studies reviewed. However, error biases (rather than accuracy differences) in the directions expected from Silverman's (1964a, 1964b) predictions have been found. At this point the significance of the differences in these error biases is not at all clear in view of the lack of evidence for a scanning effect in the sense of eye movements.

FIELD ARTICULATION STUDIES

By field articulation we refer, in this section, to the perceptual differentiation and selective perceptual articulation of complex visual patterns. The concept of field articulation has been used by cognitive style researchers to describe a factor on which tests like the embedded figures test, the rod-and-frame test and the Muller-Lyer illusion have high loadings (Gardner, 1961; Witkin, Lewis, Hertzman, Machover, Betnall-Meissner, & Wapner, 1954). Silverman (1964a, 1964b) postulated that paranoid schizophrenics were highly field independent whereas nonparanoid schizophrenics were very field dependent. He also postulated

that good-premorbid adjustment schizophrenics were field independent while poor-premorbid adjustment schizophrenics were very field dependent. Studies by Taylor (1956) using the embedded figures test and by Bryant (1961) using the embedded figures and rod-and-frame tests support the formulation by Silverman with regard to paranoid versus nonparanoid and good versus poor premorbid differences within schizophrenia. However, studies by the following researchers indicated that schizophrenic patients whether acute or chronic were significantly more field dependent than psychiatric controls and normals: Bemporad (1967), used pseudo-isochromatic plates; Draguns (1963), used blurred pictures at various levels of focus; Magaro and Vojtisek (1971), used the embedded figures test; Weckowicz and Witney (1960), used the Muller-Lyer illusion. Where acute schizophrenics were compared to chronics, in the above studies, the chronic schizophrenics evidenced greater field dependency than the acute schizphrenics except for the study of Bemporad (1967) which found the reverse. The study of Weckowicz (1960) found that psychiatric patients with evidence of organic brain dysfunction were even more field dependent than chronic schizophrenics.

Studies by Kar (1967) and Magaro and Vojtisek (1971) do not support the paranoid-nonparanoid differences postulated by Silverman (1964a) and found by Taylor (1956). Magaro and Vojtisek (1971) found that although nonmedicated

good premorbid schizophrenics tended to be more field independent than nonmedicated poor premorbid schizophrenics, both groups were more field dependent than normals. This finding is contrary to Silverman's assertion that these premorbid adjustment differences represent extremes of cognitive-style dimensions. Sugarman and Cancro (1968) found that poor premorbid schizophrenics exhibited either high or low field dependency scores on the rod-and-frame test whereas good premorbid schizophrenics had mid-range scores. In summary, it appears from these field articulation studies that schizophrenics whether acute or chronic, paranoid or not, good or poor premorbid adjustment history, do have a deficiency in selectively attending to and organizing visual gestalts in embedded and hidden figures tests, the Muller-Lyer illusion, and with blurred and pseudo-isochromatic stimuli. Where organic control groups have been included they have been found to show even less field articulation than schizophrenics.

RESEARCH ON COMPETING INFORMATION TASKS

McGhie (1966) stressed that the selectiveness of information processing was defective in schizophrenia which led to a breakdown in information processing when the amount of information available exceeded the processing capacity rate. An interrelated series of studies on selective attention in schizophrenics were carried out by Chapman and McGhie (1962),

Lawson, McGhie, and Chapman (1967), and McGhie, Chapman, and Lawson (1965). These studies employed a design in which the relevant (to be attended to) stimuli consisted of short random series of digits or letters. The same types of stimuli were used as distractors but were either presented in a different sensory modality or in the same modality but differentiated by voice-tone or location. Subjects were instructed to immediately recall information on the relevant channel. Deficit due to distraction was measured in all three studies by calculating for each subject the difference between the number of elements correctly recalled when no distraction was present minus the number of elements correctly recalled in the presence of distraction. This difference was then divided by the number of elements correctly recalled without distraction to yield a percentage distraction-deficit index. In all of the studies when series of letters were used, distraction consisted of a different series of letters presented simultaneously unless otherwise indicated. The same arrangement was used for series of digits. The elements (letters or digits) were presented for brief durations (.5 sec visual exposures) with one second inter-element time intervals. For the review which follows a greater deficit-due-to-distraction will be referred to as a greater selective attention deficit. The results of these three studies indicated the following differences: both acute and chronic schizophrenics evidenced a greater selective attention deficit than did normals and

psychiatric controls (depressives, paranoids, behavior disorders, and psychopaths) when relevant information was presented in the auditory mode, (a short series of six elements presented in a taped female voice) and distracting information was presented in the auditory mode (a different series of elements presented in a taped male voice and temporally interspersed between the relevant elements) and also when distraction was in the visual mode (a different series of elements presented visually in synchrony with the relevant auditory elements). Both acute and chronic schizophrenics evidenced a greater selective attention deficit than did normals and psychiatric controls when relevant information was presented in the visual mode (a short series of six random elements presented visually) and distracting information was presented in the auditory mode (a different series of elements presented in a taped voice and in synchrony with the relevant visual elements). This finding was presented in the study of McGhie et al. (1965) but no such deficit for schizophrenics on visual attention with auditory distraction was found in the study of Chapman and McGhie (1962). None of these studies found a greater selective attention deficit for schizophrenics when distracting information was presented in the visual mode (a different series of elements presented visually and simultaneously but around the periphery of the relevant visual elements). There is a tendency for poor premorbid adjustment hebephrenic schizophrenics to show more

selective attention deficit than other schizophrenics. There is a slight tendency for chronic schizophrenics to evidence more of a selective attention deficit than accute schizophrenics. Schizophrenics showed no more selective attention deficit than did temporal lobe epilepsy or arteriosclerotic patients in a study using the design outlined above with relevant and irrelevant information both being presented in the auditory modality (Lawson, McGhie, & Chapman, 1967) McGhie et al. (1965) found that for the simple recall of auditory or visual series, schizophrenics had significantly lower recall scores than did controls with the exception of paranoid psychotics. However, Chapman and McGhie (1962) found no significant difference between schizophrenics and controls on simple recall using the same type of task. Lastly, both acute and chronic schizophrenics evidenced less recall when they had to attend to and integrate information (series of six elements) presented in rapid series alteration between visual and auditory modalities, than did normals or psychiatric controls. It was the recall for visual elements that differentiated the groups.

Studies by Stilson and Kopell (1964), Stilson, Kopell, Vandenbergh and Downs (1966), and Ludwig, Wood and Downs (1962) found the following: Acute and chronic schizophrenics evidenced more of an impairment in recognizing geometric forms presented with static and dynamic visual noise (snow) than did psychiatric controls and normals. This was not the case when noise was absent. Acute and

chronic schizophrenics evidenced more of an impairment in shadowing speech presented with auditory noise and with speech noise than did psychiatric controls and normals. Cross-modal distraction differences (e.g. visual shape recognition with auditory noise) were not found. A study by Ludwig, Stilson, Wood, and Downs (1963) failed to find the difference between schizophrenics and psychiatric controls in speech shadowing with distraction.

Studies by Rappaport, Rogers, Reynolds, and Weinmann (1966) and by Rappaport (1967) found that both acute and chronic schizophrenics evidenced more difficulty in the written shadowing (write them down as you hear them) of sequences of 30 random numbers (rate of one per second) than did normals when the relevant message was located in the center of the auditory field and two, four, or six irrelevant messages by different voices were presented, some in the right and some in the left ear. These differences did not exist when there were no distracting messages nor did they exist when all messages were presented in the middle of the subject's sound field, i.e. diotically rather than dichotically. In the latter case both groups performed very poorly. A recent study by Rappaport (1968) failed to replicate the above differences. Lastly, Payne, Hochberg, and Hawks (1970) found that both overinclusive and nonoverinclusive schizophrenics had more difficulty verbally shadowing random three letter words as

well as phrases than did normals when similar distracting material was presented in the opposite ear.

In summary, the majority of studies reviewed in this section have quite consistently found a selective attention deficit specific to schizophrenia (with the exception of patients with organic central nervous system impairment) for both ipsimodal and bimodal distraction using recall and written shadowing responses (except in the case of both relevant and irrelevant visual elements), for ipsimodal distraction using visual pattern recognition, auditory word recognition with random ipsimodal distraction, and for the shadowing of random words and phrases using similar types of distraction. Features used to explicitly distinguish relevant from irrelevant material included sensory modality, voice-sex, location in visual space, location in auditory space and other qualitative features.

SPAN OF APPREHENSION STUDIES

As used here span of apprehension will refer to the amount of information an individual can process from a brief exposure to a stimulus display. Only the visual case is considered here.

Two of the major studies done on schizophrenics in this area were carried out by Neale, McIntyre, Fox, and Cromwell (1969) and Neale (1971) using acute schizophrenics. These

studies will be reviewed in detail since the basic procedure they used will be employed as part of the main study presented in this thesis.

Neale et al. (1969) and Neale (1971) sought an estimate of the number of elements an individual could process from a visual display of consonants that was free of response bias and not confounded with individual differences in recall. They used the paradigm given by Estes (1964, 1965, 1966). Accordingly they used a forced-choice procedure in which the subject had to decide which of two target letters, "T" or "F", had occurred on each trial. On these trials the target letter was randomly located in an imaginary 16-cell matrix amidst 0, 3, 7 or 11 other randomly selected and located consonants (Neale, 1971). Span of apprehension was estimated using the formula of Estes (1965),

$$d = \left[2\ P(C) - 1\right]\ D\ ,\ P(C) \geq .5 \quad (1)$$

where $\underline{d}$ is the estimate of span or number of elements processed, $\underline{P(C)}$ is an estimate of the probability of correctly detecting which of two equally likely target letters has occurred using the proportion of trials on which the subject is correct, and $\underline{D}$ is the number of elements in the display. As can be seen, the larger $\underline{P(C)}$ the greater is $\underline{d}$ or span, holding $\underline{D}$ constant.

The fallacy of the above model, later discussed by Cash, Neale, and Cromwell (1972) is that it assumes that a

subject processes *d* elements completely and does *not* process at all, i.e. does not process in any way relevant to deciding which target letter is present, the remaining *D-d* elements. To demonstrate this point we see that (*1*) is derived from the following:

> Given *d* elements processed completely (on the average)
>
> then $$P(C) = \frac{d}{D} + 1/2\ (1 - \frac{d}{D}),\ d \geq 0 \quad (2)$$
>
> since the subject will be correct whenever the target letter falls in the set of *d* elements processed (which has a probability of d/D) and will be correct with a probability of 1/2 when he guesses on trials on which the target letter is not among the *d* elements processed (which has a probability of $1 - d/D$).[5]

As we can see, given the assumption of either complete or no processing of any given letter, the probability of the target letter occurring in the given number of elements sampled, *d*, which have been completely processed, increases proportionally as *d* increases.

It is true that *P(C)* using the recognition forced-choice procedure (find "T" or "F") is a measure of the detectability of a target letter in a matrix of irrelevant letters that is free of response bias given that across trials there are equal numbers of "T" and "F" stimuli and that the subject evenly distributes his "T" and "F" responses over the trials. *However*, *P(C)* can be used to estimate *d* using (1) *only if* *P(C)* is purely a function of

---

[5]These derivations are paraphrased from Estes (1965).

_d_ which implies a processing model whereby each of the _d_ elements is fully and correctly processed or scanned on any given trial and the other elements are not processed at all. Let us call this approach to span of apprehension estimation the "partial report" technique. The other technique for estimating span of apprehension directly simply requires the subject to recall every letter in the matrix he can, immediately after matrix termination. This direct technique for estimating span of apprehension we will call the "full-report" technique. As you can see, holding differences in immediate memory constant, it would be possible for subject groups to differ on so-called span as measured by the partial report technique and yet not differ using the full report technique to the extent that _P(C)_ is a function of something more than span of apprehension, i.e. selectivity of attention in terms of selective perceptual recognition. The selective target-letter recognition task[6] ("partial report" task) used by Neale et al. (1969) and Neale (1971) is in many respects analogous to the visual search tasks studied by U. Neisser and his associates

---

[6]This task is usually referred to as a target letter _recognition_ task in this paper. This is according to the use of the term "recognition" in psychophysics for the denotation of a response indicating which of several possible stimuli is judged to be present by the subject. The task is referred to as a target-letter _detection_ task only in the context of the work of Neale et al. (1969) since they used the term "detection" for this task

(Neisser, 1963; Neisser, Novick, & Lazar, 1963; Neisser & Stoper, 1965). In these experiments subjects were instructed to search long arrays of letters, arranged as line lists, for one target letter, or any of several letters in the array, as quickly as possible. Search times were calculated for the length of time the subject took to scan the array line by line until he located the target letter (or letters). Scanning time per line was found to be far less than the time required if all of the letters on each line were read. In some cases a speed of ten lines per second was achieved. It was also found that multiple searches did not take longer than did searches for one target letter when subjects had been given sufficient practice (Neisser, 1967, p. 70). The subjects in these experiments reported that the non-target letters were seen as blurred while the target letters seemed to jump out from the line. These studies also indicated that search time was shorter when the target letter shared less features in common with the nontarget letters, e.g. it was more difficult for subjects to search for a rounded letter like Q in an array of rounded letters than in an array of angular letters. Neisser (1967) includes these studies of target letter search as examples of the selective visual recognition ("focal attention") process described in his theory of attention. In terms of this analogy, I am not suggesting that subjects necessarily scan or search the tachistoscopically presented arrays in a sequential fashion. The main point is that, using the

search study analogy, subjects may not fully recognize (process) the irrelevant letters in the "partial report" task employed by Neale et al. (1969) and Neale (1971). Instead irrelevant letters may only be processed (preattentively and possibly in parallel) to the point where it is clear that they contain features which exclude the possibility of their being target letters. When target letters like T and F are used, an example might be that letters with curved features are not processed beyond the detection of their curvedness. In agreement with this interpretation, McIntyre, Fox and Neale (1970) found, in a study using college students, that increasing the degree of feature similarity between target and noise letters reduced the probability of correct target-letter recognitions in tachistoscopically presented displays at brief exposure durations. Davidson and Neale (1974) agreed that a hierarchically organized selective attention process, as described in Neisser's (1967) theory, was in operation for the "partial report" target-letter detection task used in the studies of Neale (1971) and Neale et al. (1969) although individual differences in processes like speed of nonselective information processing might also be reflected in scores on this task.

Neale et al. (1969) and Neale (1971) compared the target letter detection performance of acute schizophrenics to normals (in the first study) and to nonschizophrenic psychiatric patients and prison inmates (in the second

study). They found that acute schizophrenics (whether good premorbid nonparanoid, good premorbid paranoid, or poor premorbid nonparanoid) evidenced poorer detectability for the target letters (lower P(C)) than did controls when 3, 7 and 11 irrelevant consonants were presented. No differences were found in the detectability of the target letters when no distracting irrelevant letters were presented. The matrices of letters were presented at 90 msec exposure times and 78 ftl. luminance in the Neale et al. (1969) study and at 70 msec exposure time and 6 ftl. luminance in the Neale (1971) study. Consonant matrices subtended a visual angle of 2 by 3 in both studies. These authors inferred from their data, by plugging P(C) into formula (1), that acute schizophrenics evidenced a lower span of apprehension than did controls. However, they then concluded that these differences in "span of apprehension" might be due to a deficit in the selective recognition of the target letters by the schizophrenics, faster iconic memory decay, or slower processing of information.

A study by Cash, Neale, and Cromwell (1972) sheds further light on the above studies. They used exactly the same matrix type, exposure duration, and luminance values as did Neale (1971). Matrices both 4 and 8 consonants were employed. The only difference was that Cash et al. (1972) used the full-report technique, i.e. subjects had to

immediately recall all of the elements they could after each matrix termination. No significant differences were found between acute schizophrenics and nonschizophrenic psychiatric controls. However, both groups did recall more consonants than would be expected by chance alone. The authors concluded that these results indicated no differences between acute schizophrenics on span of apprehension when compared to controls. They then inferred that the schizophrenic versus control differences found in the Neale et al. (1969) and Neale (1971) studies might have been a function of a deficit in selectivity of attention on the part of the acute schizophrenics, rather than being due to a lower span of apprehension. Davidson and Neale (1974) used a target-letter detection ("partial report") task like that of Neale (1971) except that the target letter ("T" or "F") was included in an array of five noise letters. Displays were presented at 70 msec exposure durations with a luminance of 6.0 ftl. for the stimulus exposure field and 1.5 ftl. for the fixation field. Five different sets of displays were used. One set consisted for each trial of the target letter plus five different randomly selected noise letters. The four other stimulus sets consisted for each trial of a target letter plus five identical distractor letters. The identical distractor letters were the same over trials for each of the four stimulus sets of trials with distractor letters "E", "I", "U", and "O" being used for the four sets. One experiment presented the five sets in separate trial

blocks. Another experiment intermixed the five sets across trial blocks. For both experiments it was found that schizophrenics had significantly lower target-letter detection scores than did psychiatric controls. Furthermore, both groups showed the same degree of improvement; with lowest scores for the random noise letter trial block and progressively higher scores as the distractor letters in the four identical-distractor letter sets became more disimilar from the target. Relatively acute schizophrenics were tested. In the first experiment, only, the psychiatric control sample consisted largely of alcoholics. These results point to the operation of a selective perceptual processing mechanism since target-letter detection improves when distractor letters are redundant and when distractor letters are more dissimilar from the targets. (See the earlier discussion on selective attention in search tasks). However, the finding that schizophrenics benefit just as much as controls from the redundancy and dissimilarity of distractor letters was taken by Davidson and Neale (1974) to indicate that the lower scores of schizophrenics is not a function of the selective information processing aspect of the target-letter recognition task, but rather that the lower performance of schizophrenics must be attributable to a nonselective deficit for information processing in schizophrenics such as slower information processing.

A study by Spohn, Thetford, and Woodham (1970) investigated the relationship between visual span of appre-

hension and autonomic arousal in schizophrenia. They used arrays of six consonants each presented at exposure durations of 50 msec, 250 msec, 750 msec, and 1,100 msec. Each array consisted of two rows of three consonants each. Subjects were instructed to immediately recall as many of the letters as they could. They were then to enter the letters recalled in the appropriate locations of a six-cell grid and to fill in all six cells of the grid. Spohn et al. (1970) found that schizophrenics had a statistically significant lower span of apprehension (immediately recalled less letters correctly) than did normal firemen controls for all exposure times. Schizophrenics also improved significantly less as exposure time increased than did the control subjects. The statistical tests were performed on residual scores with Wechsler Vocabulary Scale scores used as the covariate. For one testing session, using a constant 50 msec exposure duration, schizophrenics whether acute or chronic, poor or good premorbid adjustment, and whether paranoid or nonparanoid evidenced a lower span than did controls. Acute paranoid schizophrenics had a significantly lower span than did acute nonparanoid schizophrenics. For a second testing session, using the four exposure durations presented in different trial blocks, paranoid schizophrenics had significantly lower span scores than did nonparanoid schizophrenics, whether acute or chronic. Residual autonomic arousal scores, with the variance attributable to the regression of drug dosage

level on autonomic scores removed, were used in the data analysis. Amplitude of heart rate cylic variation for both before and after stimulus presentation correlated positively with level of span of apprehension equally for both schizophrenics and controls. Resting level heart rate levels and pre minus post-stimulus heart rate change scores were not significantly correlated with span scores for either group. Smaller decreases in skin conductance level, from the beginning of test trials to the middle, were found to be associated with higher span scores by the same amount for both groups. In general there was no satistically significant correlation between overall skin conductance level or response amplitude and span for either group. These results do not support the theory of Venables (1964). Venables (1964) maintained that span of attention should be extremely narrow for chronic schizophrenics and extremely wide for acute schizophrenics. The work of Spohn et al. (1970) indicates a lower span of apprehension for both acute and chronic schizophrenics compared to controls. Furthermore, overall heart rate and skin conductance level scores were not associated with span performance in either the schizophrenic or control group. This finding is contrary to Venables (1964) assertion that a higher level of arousal is associated with a more narrow span of attention.

The study of Cash et al. (1972) showed no evidence for lower visual span of apprehension in acute schizophrenics

as compared to psychiatric controls. However, the study of Spohn et al. (1970) found a significantly lower span of apprehension for both acute and chronic schizophrenics when their performance was compared to that of normal controls (firemen). The studies of Neale et al (1969) and Neale (1971) have been extensively discussed. In these studies acute schizophrenics were poorer in performance, on a task involving the selective detection of one of two target letters embedded in a briefly presented visual array of distractor consonants, than were psychiatric controls. The work of McIntyre, Fox, and Neale (1970) indicates that this task does involve a selective information processing (selective recognition) mechanism wherein irrelevant letters are only partially processed. It would appear, then, that the impaired target-letter detection performance of schizophrenic patients found in the studies of Neale et al. (1969) and Neale (1971) reflects the same selective attentional deficit for schizophrenics found in the studies reviewed in other sections of this chapter. However, the study of Davidson and Neale (1974) indicated that although schizophrenics and controls showed changes in target-letter detection performance which are congruent with the utilization of a selective attentional processing mechanism, the lower performance of schizophrenics did not appear to be attributable to this mechanism. Instead it was concluded that the schizophrenic deficit lies in the area of a slower processing

of information (selective or nonselective). The work of Yates and Korboot (1970) studied the performance of schizophrenics and neurotics on a task in which subjects were asked to inspect visual displays (all lines, words, or symbols) until they knew the number of elements in the display. Chronic nonparanoid and paranoid schizophrenics as well as acute nonparanoid schizophrenics gave significantly longer inspection times than did neurotics (acute and chronic) and acute paranoid schizophrenics. No subjects made any errors of inspection. These results were replicated by Korboot and Yates (1973) comparing chronic nonparanoid schizophrenics to chronic psychotic depressives. Inspection times did not differ between chronic paranoid schizophrenics and chronic psychotic depressives. These results point to a selection of longer visual inspection times for schizophrenics (especially chronic nonparanoid schizophrenics) as compared to psychiatric controls on a span-of-apprehension type task using numerosity. As pointed out by Yates and Korboot (1970) these results are congruent with Yates' (1966) theory of slower information processing in schizophrenia as opposed to a specific inability to selectively process information. Of course the results of Yates and Korboot (1970) are not conclusive since many other factors other than the need for more time to process information may determine the selection of longer inspection times by schizophrenic subjects. In terms of the findings reviewed in this section

the central question is one of at what stage or for what aspect of the process of selective organization of visual information schizophrenics have difficulty in processing information.

THEORIES OF SELECTIVE ATTENTION AND INFORMATION PROCESSING IN SCHIZOPHRENIA

In this section general theories of selective attention are reviewed. The findings reviewed in earlier sections of this chapter are summarized and the main study presented in this thesis is formulated in terms of an outline of possible points in the process of selective visual recognition where schizophrenics might differ from control subjects.

Theories of Selective Attention

Essential to current models of selective attention, memory, and human information processing to be discussed, is the belief that the human organism is not capable of processing and responding to all the input present at the receptor level at the rate at which it is commonly presented in everyday life. This is especially the case when the rate of information input is heightened such as in interference studies, parties, and dichotic listening. This is also the case when receptor input is only present for very brief durations as in the tachistoscopic presentation of visual material. The theories reviewed,

concentrate on voluntary attentional mechanisms more than on the involuntary control of attention by stimulus properties and motivational processes.

Broadbent (1958) was one of the early theorists in the area of selective attention. He proposed that incoming information is held in a short-term pre-perceptual memory store. The information decays rapidly and is lost if it is not selected by a filter for further processing in a limited capacity information processing channel. That which is not processed is that which is actively kept put by the filter. This filter operates like a sieve or color filter. Information might be filtered using various physical characteristics such as pitch or location in auditory perception, or color, size, or other feature characteristics might be used in visual perception. In Broadbent's theory the filter operates on stimulus properties (stimulus set) rather than on properties which require elaborate post-perceptual conceptual classification (response set).

The theoretical propositions of Broadbent (1958) have not held up to experimental investigation. Findings contrary to his proposals include the following: 1. Subjects can recognize their names in the "filtered out" auditory channel (Moray, 1959). 2. If two separate voices are presented one of which is being selectively attended to and shadowed, and the secondary "irrelevant" voice is

speaking the same message but lagging behind in time, subjects realize that both messages are the same (Treisman, 1964a). 3. When two messages are presented, one in each ear, and one is being selectively attended to and shadowed, subjects shift to the secondary "irrelevant" channel when the words on that channel follow contextually from the message thus far presented in the primary channel. That is, when the ear-localization of the message is switched in mid-stream subjects quite readily continue to shadow the same message (Treisman, 1960).

Treisman (1960) sought to extend Broadbent's model to account for findings such as the above by postulating that the filter simply attentuated the message in the secondary irrelevant channel. Furthermore, she postulated that sequentially implemented hierarchies of tests, which lead to the identification of perceptual units, such as words, have various cutoff points or criteria associated with them at each test point in the hierarchy. Attentuation is viewed in terms of the cutoff point in the hierarchy to which tests are carried out. Therefore, for the overall attentuation of information in the irrelevent channel, pro cessing is terminated early in the sequence of tests. However, contextual dependencies may shift cutoff points so that certain information in the irrelevant channel is more fully processed (Treisman, 1964b). As pointed out by Hochberg (1970), by the time one considers all of the

addenda to the filter model made by Treisman, one has come close to the model of selective attention and perceptual organization put forward by Neisser (1967) and Hochberg (1970). This model is called "analysis-by-synthesis" by Neisser (1967) and "anticipatory encoding" by Hochberg (1970).

The analysis-by-synthesis theory postulates, on the basis of the work of Sperling (1960), Averbach and Coriell (1961), Pollack (1959), Eriksen and Johnson (1964) and many others, that information arriving at the visual and auditory receptors is held in a sensory memory after stimulus termination. In the course of the duration of sensory memory all potential information is still available for further processing. For vision, sensory memory is called "iconic memory" and is estimated to last from several hundred milliseconds to one second after stimulus termination. A stimulus duration exceeding 50 msec does not seem to extend the duration of iconic memory although smaller exposure times can reduce its effective duration. For audition, sensory memory is called "echoic memory" and is estimated to last one or two seconds. According to the analysis-by-synthesis model of Neisser (1967) information held in sensory memory is passively preattentively processed in parallel (spatially and operationally parallel processing) all over the sensory field. Preattentive processing of visual and auditory information held in iconic or echoic memory is global and wholistic. Preattentive processing segregates the array

of stimulation into units, allowing for the detection of simple features and global properties of the stimulus array. Focal attention, as described by Neisser (1967), involves the allotment of an active process of information extraction and organization, called analysis-by-synthesis, to the preattentively processed information held in sensory (iconic or echoic) memory. Analysis-by-synthesis, as the name suggests, is considered to be a constructive synthetic hierarchically organized covert activity by which one builds visual or auditory perceptual objects. This process consists of the generation of tentative syntheses or recognition unit hierarchies on the basis of the preattentively processed information present in sensory memory. Synthesis are refined or altered until an object is constructed which conforms to the preattentively processed information. The selective or focal aspect of attention is viewed as the directed allotment of the process of analysis-by-synthesis to specific portions or aspects of the stimulus array. This selection is based upon critical features which can be discriminated at the level of preattentive processing. Examples would be spatial location, color, size, pitch and critical features preprimed by the selective activation of particular recognition units (or recognition unit hierarchies). All of the examples just given depend upon discriminations made at a preattentive level of analysis. Thus, selective attention in the sense just described involves selectivity at a pre-

perceptual earlier level of information extraction, a "stimulus set" rather than a "response set". As maintained by Kahneman (1973) there is considerable evidence to indicate that selective attention tasks wherein relevant and irrelevant stimuli are discriminated according to physical characteristics such as spatial location, size, color, and pitch involves the same selection mechanism as to selective attention tasks wherein relevant stimuli are designated targets, e.g. the letters "T" and "F". In both types of tasks, selection of input is made at the early level of preattentive processing on the basis of features detected at this early level. According to Neisser (1967) information which is synthesized by the process of analysis-by-synthesis (information which is encoded) is accurately recognized and responded to and is available for storage in a longer lasting active verbal memory (short-term memory). On the other hand information which does not receive the benefits of analysys-by-synthesis simply fades away with the decay of sensory memory. Thus, Neisser sees no necessity for the postulation of an active filtering out or attentuation of irrelevant information. Information which is not attended to, simply fades away. Hochberg (1970) presents a model of selective attention which is almost identical to that of Neisser (1967). What Neisser refers to as a process of analysis-by-synthesis, Hochberg refers to as a process of anticipatory encoding. That which is perceived is that which confirms a hierarchically organized

and context dependent set of perceptual expectations. As pointed out by Kahneman (1973), one difference between the two theories is that for Hochberg conscious perceptual awareness depends upon the storage in active verbal memory of perceptual analysis (information as to which expectations were confirmed). For Neisser, however, conscious perceptual awareness simply depends upon the perceptual analysis itself without necessitating the storage of the results of perceptual awareness in active verbal memory. Kahneman (1973) disagrees with both theorists claiming that contact with perceptual recognition units does not necessarily lead to conscious awareness and that it is the violation of expectations rather than their confirmation which promotes conscious perceptual experience. This belief is based on his hypothesis that perceptual effort and awareness are highly correlated. Redundant easily confirmed information requires little effort for its perception and hence is easily lost from awareness. Kahneman (1973) presents a model of selective attention which is very similar to the models of Neisser (1967) and Hochberg (1970). Some of the unique aspects of his theory include the following: He postulates the existence of a figural emphasis process which follows the preattentive processing of Neisser's theory and precedes the activation of recognition units. Figural emphasis determines the size of the unit of perception which is given attentional emphasis and the particular unit of that size to be emphasized. In essence "figural

emphasis" corresponds to the initial levels of active perceptual synthesis in Neisser's (1967) process of analysis-by-synthesis. Furthermore, Kahneman (1973) proposed that the activation of perceptual recognition units (syntheses) is followed by a stage called "selection of interpretations." This stage refers to a selection among a number of equally likely perceptual recognitions which have been generated by the activation of recognition units. Interpretation is critical to the extent that stimulation is ambiguous. He believed that conscious awareness is contingent upon the selection of interpretations. Inattention to stimuli at early levels of processing results in impoverished interpretations of these stimuli and hence a minimal degree of awareness. Stimuli that have been attended to have received more effort and result in highly articulated interpretations and hence a high degree of awareness associated with them.

Selective Attention in Schizophrenia

The extensive experimental evidence on selective visual and auditory attention, critically reviewed in the works of Neisser (1967), Hochberg (1970), and Kahneman (1973), gives a great deal of support for the basic attentional model these three theories share in common. Little support however is provided for the filter theory Broadbent (1958) or the notion that all selective attention is post-perceptual

as presented in theories by Deutsch and Deutsch (1963) and Norman (1968). To recapitulate, the following stages of perceptual organization and storage are postulated to take place in the selective attention process, using Neisser's theory. All of the potential sensory information is present for the duration of the stimulus plus the duration of sensory memory (iconic or echoic memory). At this level information is crudely preattentively processed in parallel, allowing for the discrimination of certain physical properties like spatial location, color, pitch, and stimulus features critical to the synthesis of particular perceptual objects (targets). Next, an active encoding process ("analysis-by-synthesis", "anticipatory encoding") constructively extracts information from sensory memory. Encoding priorities (perceptual sets) determine the particular perceptual objects which are to be constructed from the information available in sensory memory. In different terms, encoding priorities determine the information which is to be extracted before sensory memory has decayed. Information which is encoded is stored in an active verbal memory (short-term memory) and can be recalled. Information which is not encoded is lost. The limit on the amount of information which can be encoded depends on the amount of time available for encoding (length of rate of stimulus presentation), the speed with which the information can be encoded and the limited capacity of the active verbal memory system. Authors such as Sperling (1960)

have claimed that, with visual elements presented tachistoscopically at the commonly used exposure durations of around 50 msec, the limitation on the number of elements (e.g. letters or digits) which can be recognized and immediately recalled correctly (span of apprehension) is not due to the normal rate at which elements are processed. He claims instead that the limit on span of apprehension is the limit on the number of items which can be held in active short-term verbal memory. In other words he claims that the limit on visual span of apprehension is due to the limit on span of immediate memory (active verbal memory). However, Neisser (1967) has pointed out that at exposure durations of 50 msec the span of apprehension is usually about four or five elements whereas the span of active verbal memory averages about seven elements. Neisser claims that the fast processing rates necessary for tachistoscopic recognition of elements reduces the memory capacity for these elements and cites evidence to support this contention (Neisser, 1967, p. 222). This claim, in effect, means that the information cannot be encoded rapidly enough at a rate that would allow for the utilization of the full capacity of active verbal memory. In further support of the idea that the limit on span of apprehension is not the capacity of active verbal memory, studies by Mackworth (1963) demonstrate that the span of apprehension steadily increases as exposure time increases from 100 msec to 4 sec. At 4 sec the usual limit (about seven letters recalled) of active

verbal memory is reached.

In view of the model outlined above the specific ability to selectively attend depends upon the ability to form, maintain and apply selective perceptual sets (encoding priorities) to the already preattentively and passively processed information held in sensory memory. Selective perceptual sets may be voluntarily maintain, determined by contextual expectancies, or determined by motivational factors. When selective attention tasks are given to a subject, deficient performance could result from: a primary inability to voluntarily form and maintain a selective perceptual set; the intrusion of irrelevant perceptual sets; a faster decay or degradation of preattentively processed information held in sensory memory, which would result in less information being available for selective encoding; an inability to synchronize or otherwise interface selective encoding operations with the time of occurance of information in sensory memory; a slower rate of selective encoding; or the loss of already selectively encoded information in an inefficient active verbal memory system or through interference during the recall of the information.

The studies reviewed in this chapter have provided extensive evidence that schizophrenic patients have relatively deficient performance on tasks explicitly requiring the selective perception and recall (or shadowing) of information presented in visual and auditory modalities when

compared to psychiatric controls and normal subjects. Evidence was also presented for an attentional performance deficit when relevant information was presented in one sensory modality and irrelevant information was in the other modality (for vision and audition). This lower attentional performance by schizophrenic patients may be the result of any of the alterations listed in the preceding paragraph. Field articulation studies revealed more field-dependency for schizophrenics as compared to controls. This may reflect a deficiency in the initial preattentive segmentalization of input and/or a primary disorder in the ability to maintain a selective perceptual set. Kahneman's (1973) intermediate stage of figural emphasis could be the point at which schizophrenics are unable to selectively locate figures in tests of field dependency such as the embedded figures test. The studies on perceptual constancy were equivocal with respect to differences between schizophrenic patients and controls. However, evidence reviewed indicated that if there is a difference it is in the direction of an inefficiency in estimating the size of distal objects rather than an error bias for under or over-constancy. This could signify an inability to select among post-recognition alternatives in the interpretation stage of Kahneman's theory. The size estimation studies point to error biases rather than accuracy differences for schizophrenics. This may indicate that one set of post-recognition interpretations may be preferred

over another depending on the schizophrenic subcategory.

The reaction-time studies reviewed pointed to an inability on the part of schizophrenics to maintain a sensory-motor set with respect to the temporal predictability of stimulus events. Studies using tasks other than RT also pointed to a sensory-motor synchronization impairment for schizophrenic patients. This impairment might reflect a primary inability to maintain a set or the presence of interference from competing sensory-motor sets, as described in Shakow's (1962, 1963) theory of segmentalized set in schizophrenia. The possibility of response-inhibition serving to interfere with the maintenance of a major accurate temporal sensory-motor set in schizophrenia was also discussed. In the area of visual span of apprehension and the selective perception of target letters embedded in briefly exposed visual arrays of letters, it is not clear at what point or points in the selective attention process schizophrenics have impaired functioning. It is this problem which is discussed in the next section.

Theoretical Formulation of the Main Study

The main experimental study presented in Chapter III was designed to help clarify at what point or points in the process of selective visual perception schizophrenics have impaired or altered functioning. The study employs two visual perceptual tasks. Both tasks are patterned

after the experiments of Neale et al. (1969), Neale (1971) and Cash et al. (1972). The selective attention task is, in most critical respects, the same as the target-letter detection task employed by Neale (1971) and Neale et al. (1969). Subjects are required to selectively recognize which of two equally likely target letters is present in a visual array of distractor consonants presented for a brief tachistoscopic exposure duration (50 msec). This task, as well as attentional theories used to describe it, has been extensively analyzed and discussed in this chapter. This task entails the selective encoding of letters in the stimulus array such that irrelevant letters are only partially and incompletely processed. However, other factors such as speed of perceptual encoding or a degraded visual input would contribute to individual differences in performance on this task. The span of apprehension task is similar to the full-report technique used by Cash et al. (1972). This task was used in order to provide a measure of perceptual encoding efficiency which does not require the subject to selectively process and recognize the letters in any way which would improve his performance score. Besides providing information as to the span of apprehension for schizophrenics as compared to control subjects, the span task provides a baseline measure with which to contrast performance scores on the selective attention task. In order to obtain a measure of span of apprehension which was free of possible contamination by response

interference factors during recall, a post-stimulus recognition measure of span was developed (see Chapter II) and then employed in the final study. Rather than have subjects recall and recite the consonants they had perceived and remembered, subjects simply had to select which of two consonants, presented after the stimulus, they recognized as having been present in the letter array just viewed. The post-stimulus alternatives were not known in advance of each trial. They were presented at a post-stimulus time interval which was estimated in the pilot studies to allow a sufficient time lapse for the decay of iconic memory (see Chapter II). Each subject received both perceptual tasks. Research by Bauman and Murray (1968) indicated that acute schizophrenics had significantly lower recall but not recognition for lists of words presented on a memory drum. The post-stimulus recognition procedure employed in the assessment of span of apprehension was utilized in an attempt to avoid a schizophrenic deficit in recall by utilizing a recognition measure of the elements which had been perceived and memorized.

The objective temporal predictability of the stimulus arrays was manipulated as a between-subjects factor. This factor was not manipulated within subjects because of the extensive amount of time that would be required to run each patient as well as the possibility that a within-subjects manipulation might confound effects of temporal predictability with the ability of patients to shift from

one condition to another. This manipulation was introduced to examine the possibility that the temporal synchronization difficulty evidenced for schizophrenics, in tasks assessing the ability to engage in sensory-motor synchronization with respect to temporally predictable sequences of external stimulation, might be manifested in a visual selective attention task requiring the selective recognition of target letters. For the selective visual attention task employed, it was maintained earlier that one point in the selective attention process necessitates the temporal synchronization of selective encoding operations (perceptual sets) with the time of occurance of information for stimulus duration plus sensory memory lapse. On the basis of this assumption it was expected that if it was the synchronization impairment (evidenced for schizophrenics in the RT and motor synchronization studies) which made it more difficult for schizophrenics to selectively attend to visual targets, then the following experimental effects and interaction would be found. Control subjects would show a marked increase in selective target-letter recognition as the onset times of the stimulus arrays became more temporally predictable. This was based on the formulation that temporally unpredictable stimulus arrays would impair the ability of control subjects to synchronize the application of the selective encoding operations (target-letter perceptual sets) to the time of occurance of the stimulus array, since the time of occurance could not be

predicted. Some evidence was obtained for such a relationship in pilot experiment 1 (see Chapter II). On the other hand schizophrenic subjects were not expected to show as much improvement on the visual selective attention task as the onset times of the target arrays became more predictable, since their assumed synchronization impairment would made the increased temporal predictability of the stimulus arrays relatively unbeneficial to them, i.e. they would not be able to take as much advantage of the increased temporal predictability of stimulus onset. Such an interaction might also obtain for the span of apprehension task to the extent that a possible non-selective perceptual priming could be synchronized with the temporal predictability of stimulus onset. There was no evidence for this in the pilot experiments (see Chapter II). The measure of temporal predictability used was the interval of temporal uncertainty (ITU) which has been found to be associated with the detection of auditory signals with noise (Egan, Greenberg, & Schulman, 1964). A self-initiate condition in which the subject triggered the stimulus onset himself was also included. Shakow (1962) would predict that schizophrenics would do worse under this condition while controls would improve. This is predicted on the basis of his finding, using experimenter vs. subject control of preparatory interval in RT studies, that in schizophrenia there is a negative relationship between the autonomy or control given and performance whereas the

reverse is true for control subjects. On the other hand schizophrenics might do best under this condition since autosynchronization of functioning might be less impaired in schizophrenia than the timing of perceptual processes with temporal patterns of external stimulation.

A tap-click timing task was also given to schizophrenic subjects and controls. This task was patterned after the study of King (1962). The employment of this task allowed for the detection of subject-group differences in the synchronization of motor behavior (tapping) to temporally predictable regularly occuring stimulus events (clicks), i.e. the maintenance of sensory-motor synchronization. Furthermore, it was desired to assess group differences in constant error scores as compared to measures of variable error. Lastly, the estimation of correlations across subjects, within each group, between perceptual selective performance and constant and variable error scores on the tap-click sensory-motor synchronization task was planned in order to provide an indication as to whether or not individual differences in perceptual selective attention and sensory-motor synchronization both might reflect individual differences in the maintenance of a major set.

CHAPTER II

PILOT STUDIES

Four pilot studies on the visual recognition of tachistoscopically presented arrays of consonants were conducted on groups of undergraduate university students. These studies served as a methodological preparation for a main set of experiments on selectivity of attention to visual information and span of apprehension in schizophrenic and nonschizophrenic psychiatric patients at a local mental institution. These pilot experiments provided an opportunity for assessing the extent of the relationship between the temporal uncertainty of brief visual exposures of letter arrays of consonants and performance on a task requiring selective perceptual recognition of letters and a task measuring span of apprehension. Parameters such as array size and exposure duration were explored. The length of visual-spatial iconic sensory memory with a final set of exposure duration and brightness parameters was measured as part of the design of a procedure for assessing span of apprehension that was relatively free of response interference during recall.

PILOT EXPERIMENT 1

The purpose of this experiment was to explore the extent and form of the relationship between the temporal uncertainty of brief visual exposures of displays of consonants and performance on a task requiring selective visual recognition. The independent variable was the amount of temporal uncertainty of the stimulus onset and the dependent variable was the recognition, on each exposure, of one of the two target consonants used in the experiment. Either target consonant was embedded in an array of distractor consonants. The parameters of display size and exposure duration were also included in a factorial arrangement.

Method

Subjects

A sample of 24 undergraduate students taking first-year psychology courses served as subjects. Nonsense code names used for the research sign-up booklets minimized the likelihood that subjects would be aware of the type of experiment they were volunteering for. The students received course credit for their participation. Twelve males and 12 female students were tested. Each subject was tested individually in a session lasting approximately one hour including breaks. The mean age of the 24 students was 18.7 years with a range of 17 to 23 years old. Students wore their own corrective lenses during the ex-

periment if these were needed. All of the 24 students had 20/30 or better corrected near visual acuity as measured by an eye chart for near vision at a distance of 14 in. (35.6 cm).

Design

Four independent variables were included in the experiment.

Interval of temporal uncertainty. This factor consisted of three levels of the objective temporal predictability of briefly exposed letter arrays. Interval of temporal uncertainty (ITU) was the measure of predictability employed. The ITU is the time interval during which the visual stimulus may have its onset. In other words, the value of a particular ITU is the range of possible onset times for the stimulus. On any given trial the appearance of the stimulus within the ITU was entirely random, i.e. the probability distribution of stimulus onset times within the ITU was rectangular. Each of the ITU conditions had the same midpoint of 3.0 sec. The three ITU conditions were ITU = 0 sec, the visual stimulus always appeared exactly 3.0 sec after the warning tone; ITU = 2 sec, the visual stimulus could appear anytime from 2.0 to 4.0 sec after the warning tone; ITU = 5 sec, the visual stimulus could appear anytime from 0.5 to 5.5 sec after the warning tone. These three levels of uncertainty constituted the first between-subjects factor.

Display size. Two sizes of consonant arrays were employed. One size consisted of stimuli made up of four different consonants randomly located for any given trial in any of 16 possible locations in an imaginary 4x4 matrix of locations on the screen in the center of the subject's visual field. One and only one of these consonants was always either a capital "T" or "F" target letter. The second display size condition was the same as the above except that eight consonants, including the target letter, were presented. These two sizes of display constituted the second between-subjects factor.

Exposure duration. Displays of consonants were given in two separate trial blocks within each subject. In one of the trial blocks the consonant array for each trial was exposed for 50 msec. In the other trial block each trial consisted of a 30 msec exposure of the consonant array.

Order of exposure duration conditions. For any given ITU by display size contingency, half of the subjects received the 50 msec exposure trial block first and then the 30 msec trial block. The other half of the subjects received these two trial blocks in the reverse order.

The design then consisted of a 3 (ITU) x 2 (Display Size) x 2 (Exposure Duration) x 2 (Order) factorial arrangement. Exposure duration was a within-subjects condition. The other three conditions were between subjects. One

male and one female subject were randomly assigned to each of the 12 cells.

Apparatus

The stimulus displays consisted of arrays of consonants which were constructed as follows: an IBM Selectric typewriter with a number 10 Orator element was used to type upper-case consonants on a white, unlined 3x5 in. index cards. Cards were mounted on 12.8 x 24.3 cm Masonite boards for insertion and withdrawal from the tachistoscope. Two sets were constructed. Each set consisted of 16 practice cards and 64 test cards. One set consisted of arrays of 4 consonants. The other set consisted of arrays made up of 8 consonants. These two sets were further divided into two subsets each, each subset consisting of eight practice trials and 32 test trials. Letters were allocated after the manner of Neale, McIntyre, Fox and Cromwell (1969). An imaginary 4x4 matrix of 16 letter spaces was located in the center of each card. Each array contained one and only one of the two target letters a T or F, plus the appropriate number of additional noise letters; for each subset each of the target letters appeared once a separate card in each of the 16 possible matrix positions yielding a total of 16 test-trial cards with target letter T and 16 test-trial cards with target letter F. The eight practice trial cards included four cards with the target letter T and four cards with the target letter F.

The location of the target letter was independently randomly localized for each of the eight cards without any restrictions. For each of the stimulus cards the appropriate number of nontarget distractor letters was randomly drawn without replacement from the remaining 19 consonants of the alphabet (including the letter Y). They were then randomly allocated to either three (four-element arrays) or seven (eight-element arrays) of the positions remaining in the imaginary 4x4 matrix after the target letter had been positioned. A random permutation of the practice and test trials for each subset was performed after the cards were typed. This insured that the occurence of a T or F target letter on each trial was randomly permuted across the practice and test trials. The two respective permutations for each of the two blocks of cards, one for each of the two exposure duration conditions, were held constant for each subject. This also held true for the sets of practice trials.

The imaginary 4x4 matrix covered an area which subtended a visual angle 1° 46' (.0308 rad) wide by 2° 5' (.0363 rad) high. Each letter subtended a visual angle 8' 28" (.0025 rad) wide by 16' 55" (.0050 rad) high. There was a border to border 23' 16" (.0068 rad) horizontal and 19' 2" (.0055 rad) vertical separation between the characters in the imaginary 4x4 array. In other words these are the minimum interconsonant separation distances possible for any given array. Figure 1 gives an example of

an array of consonants.

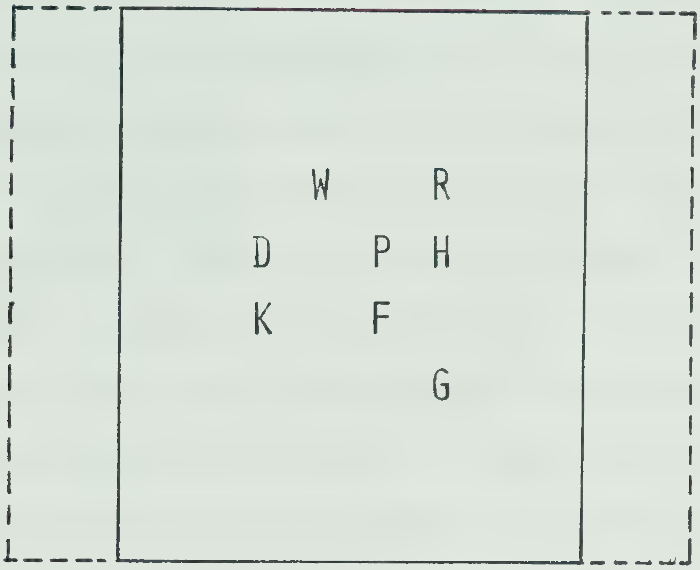

Figure 1. An example of an array of consonants in the actual size and type of the original. The retinal angle subtended by the frame is drawn in scale. Solid lines are for Pilot Experiment 1. Dashed lines are for the main study.

The displays were presented in a Scientific Prototype Model 800E two-channel tachistoscope. The center of the pre-post stimulus fixation field contained a small black dot on which the subject was instructed to fixate after he said that he was ready at the beginning of each trial. The dot subtended a visual angle of 4' 14" (.0012 rad). The subject viewed the fixation field and stimulus arrays through a rubber face-rest viewer with his head covered by a black opaque black cloth which was attached to the viewer. The stimuli and fixation dot were at a respectively real and apparent distance of 81.3 cm from the subject. Both

the stimulus and fixation fields consisted of a rectangle of illumination framed by a completely dark surround. The framed visual field covered an area which subtended a visual angle 4° 7' (.0719 rad) wide x 4° 57' (.0863 rad) high. All viewing was binocular. The fixation field had a luminance of 1.5 ftl. and the exposure field had a luminance of 6.0 ftl. Clear partially exposed transparent film sheets were employed as filters to provide reduction of luminance with the finer adjustments being made with the lamp controls on the tachistoscope. These were used instead of neutral density filters which were not available at the time. The use of filters avoided the possibility of any flicker that might occur during stimulus onset or offset with a partially ignited bulb at the low setting necessary for filter-free attainment of the luminance values desired. These filters provided the same distortion-free articulation of the stimulus field attainable with neutral density filters.

After the card was inserted into the tachistoscope the experimenter initiated the trial sequence after the subject said that he was ready. A button held by the experimenter triggered a Hunter Model 111-C Series D Decade Interval timer. This timer controlled the duration of a .4 sec warning tone of 2.5 kHz, at 65 db., delivered by a Sonalert tone device. Warning tone offset initiated the preset preparatory interval. The preparatory interval was controlled by a Western Bio-research Model 500 Preset timer.

When the preparatory interval had elapsed the tachistoscope was automatically triggered and the onset of the letter-display exposure was instantaneously initiated. For the 0 ITU condition the preparatory interval (PI) was held constant at 3.0 sec for all practice and test trials. For the 2 ITU and 5 ITU conditions, for each subject, PIs were randomly sampled with replacement for each of the practice and test trials with the restriction that at least one of the lowest and one of the highest possible PI values be present in the sequence of 32 test trials for each of the two exposure duration test-trial blocks. Possible PI values were graded in .1 sec intervals ranging from 2.0 to 4.0 sec for the 2 ITU condition and ranging from 0.5 to 5.5 sec for the 5 ITU condition. Each subject received a different set of PI values.

Procedure

Each subject was given a standard set of instructions. The subject was instructed to fixate on the dot after he indicated that he was ready and to maintain the fixation until the letter array had disappeared from the screen. He was told the number of consonants that would be contained in the letter arrays he would be shown. A 4x4 matrix of crosses was used to demonstrate the possible locations of the consonants on the screen. The five vowels A, E, I, O and U were shown and the subject was told that these vowels would never appear on the screen. The consonants

were then shown and recited to the subject. He was told that on each trial one and only one of the two target letters, a T or an F, would be present in the array and that these were equally likely on any given trial. The location of the target as well as distractor letters was said to be completely randomized for each trial. Four examples of letter arrays were then shown to the subject at 500 msec exposure times. The subject was then instructed to discover which target letter was present in the display for each of three trials presented at either 30 msec or 50 msec depending on when exposure duration order condition the subject was assigned to. After each of these three trials he was given an opportunity to view the same display at a 500 msec exposure. Then the subject was instructed, "We are not interested in how well you can perceive the other irrelevant letters that accompany the target letter.... On each trial simply selectively attend to whether a T or an F has appeared and report your decision as soon as the array has disappeared. If you are not sure, give your best guess." Then the ITU condition was explained and the warning tone and a letter array were used to demonstrate the range of possible preparatory intervals between the tone and the stimulus onset. Subjects were instructed to fixate on the dot when they said they were ready and to hold the fixation until the stimulus display had disappeared. In order to use substitute cards in trials where the subject happened to blink, subjects were instructed,

"If the letter display fails to appear please let me know." These instructions did not heighten the subjects possible concern about blinking. Only a few if any such trials actually occurred for each subject. The overall procedure was tried out twice and then the eight practice trials were given followed by 32 test trials for the first exposure duration condition (either 30 or 50 msec). After a break the subject was told about a change in the exposure duration. Then eight practice trials and 32 test trials were given for the second exposure duration condition (either 50 or 30 msec). Subjects were also given short breaks after the first 16 test trials for each of the exposure duration conditions.

Results

The measure of the dependent variable was the number of correct target-letter recognitions for each of the two stimulus exposure duration trial blocks. A 3 (ITU) x 2 (Display Size) x 2 (Order of Exposure Duration) x 2 (Exposure Duration) analysis of variance was performed with all factors being between subjects except for exposure duration which was within subjects. Two subjects were randomly assigned to each cell of the factorial arrangement of between subject factors. A significant main effect was present for display size, $F\ (1,\ 12) = 8.60,\ p < .05$. The F ratio for the ITU main effect was not statistically significant although there was a trend in the expected

direction of a decrease in performance under larger as compared to smaller ITU conditions, $F(2, 12) = 2.50$, $p = .25$. For all of the remaining main effects and interactions the F ratios were less than unity. The data were converted to proportions and the transformation $\phi = 2 \arcsin \sqrt{P}$ was performed as suggested by Winer (1962, p. 221). An analysis of variance was performed. The conclusions were the same as for those of the untransformed analysis. A significant main effect was found for display size, $F(1, 12) = 11.93$, $p < .005$. The F ratio for the ITU main effect was higher though still not achieving statistical significance, $F(1, 12) = 2.83$, $p < .10$. All of the remaining main effects and interactions were not statistically significant and close to unity. Due to the small number of subjects and the exploratory nature of the study, Duncan's multiple range test was carried out on the simple main effects of ITU at the two display sizes using the untransformed data. The means did not differ for the four-consonant display size. However, there was a significant difference ($p < .05$) between the 0 ITU and 5 ITU condition at the eight consonant display size. Duncan's multiple range test was carried out for the simple main effects of display size at the three ITU conditions. Subjects under display size eight performed significantly lower ($p < .05$) than did subjects under the four element condition at the 5 ITU condition only. A graph of the means for the display size and ITU conditions is shown in Figure 2. All of these

means significantly exceeded the 50% chance level of responding ($p < .01$, one-tailed).

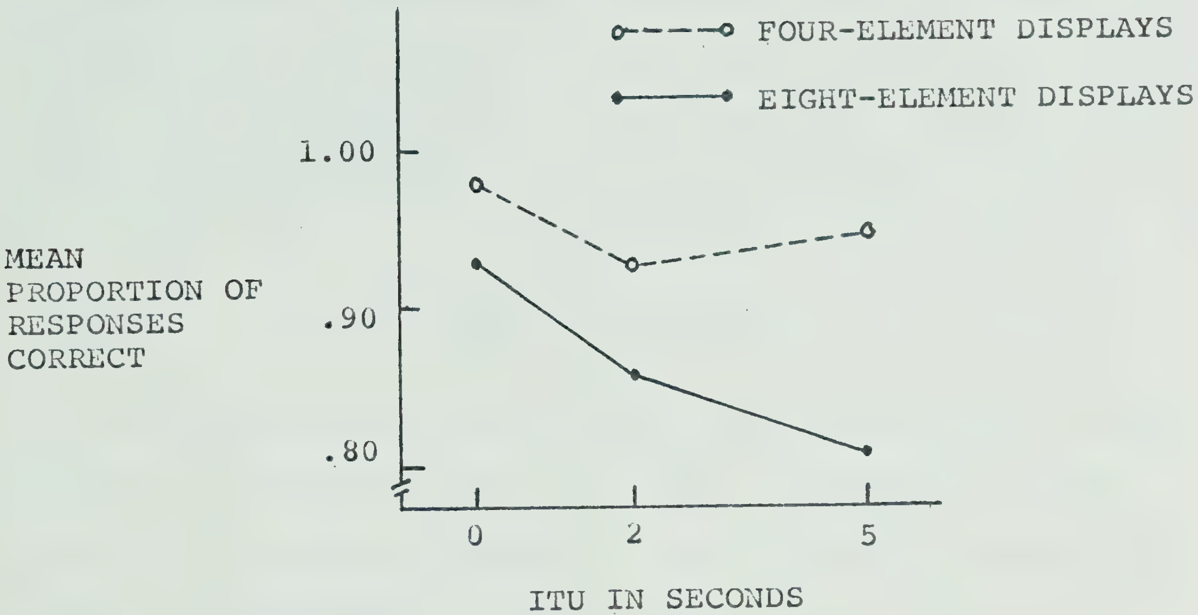

Figure 2. Mean proportion of correct responses as a function of the interval of temporal uncertainty (ITU) for the two display size conditions.

As found by Neale et al (1969) subjects performed better when only three as compared to seven distractor consonants were present. Furthermore, these data indicate, although weakly, that when the task is difficult enough, as in the eight-consonant display size condition, ITU is a determinant of selective perceptual recognition. Under the eight-element condition the subject has to rely more on selective processing of the information than in the four-element condition in order to achieve optimal performance. It is under the eight-element condition that subjects evidenced higher performance when display onset was per-

fectly predictable (0 ITU) than when it could occur by chance within a five second interval (5 ITU). On the basis of these results it was decided to include the ITU variable in the main study on psychiatric patients. For the remaining pilot studies and the final study only eight-element display sizes were used. This study indicated no difference between the 50 msec and 30 msec exposure conditions.

PILOT EXPERIMENT 2

Performance on the selective recognition task outlined in pilot experiment 1 may be in part a measure of selectivity of perceptual recognition and in part a measure of span of apprehension, the number of elements that can be nonselectively recognized. It was decided to explore the effect of ITU and exposure duration using a nonselective span of apprehension task. It was expected that such a task would provide a baseline measure of span to be compared to selective recognition performance in the main study on psychiatric patients.

Method

Subjects

A new sample of the same population of undergraduate students described in pilot experiment 1 was used for this study. Six males and six female students were tested. The mean age of the twelve students was 20.1 years with a

range of 18 to 26 years old. All of the students had 20/30 or better corrected near visual acuity. The session took approximately one hour including breaks.

Design

Three independent variables were included in the experiment. These were ITU, exposure duration and order of two within-subjects exposure durations (50 msec and 30 msec). These three conditions are exactly the same as those described in pilot experiment 1. Exposure duration was the only within-subjects factor. Order of exposure duration conditions and ITU were between subjects conditions. The design then consisted of a 3 (ITU) x 2 (Exposure Duration) x 2 (Order) factorial arrangement. One male and one female subject were randomly assigned to each of the six between-subject cells. The dependent variable was the mean number of consonants correctly recalled from a brief exposure (30 msec or 50 msec) to a display of eight consonants.

Apparatus

The equipment and stimulus materials were exactly the same as those described in pilot experiment 1 with the exceptions which follow. Stimulus materials consisted only of arrays of eight consonants. The consonants T and F had the same relevance as any of the other 19 consonants of the alphabet. For each of the stimulus cards eight consonants were randomly drawn without replacement from the

21 consonants of the alphabet (including the letter Y). They were then randomly allocated to eight of the 16 positions in the imaginary 4x4 matrix.

Procedure

The instructions are exactly the same as those used in pilot experiment 1 except that the subject was not instructed to selectively attend to whether a T or an F was present on the screen. Instead, subjects were instructed to perceive as many consonants as they could and report them as soon as the display of letters had disappeared from the screen. Subjects were required to report eight letters on each trial in order to control for the possibility of more guessing on the part of some subjects as compared to others.

Results

The measure of the dependent variable was the mean number of correctly recalled consonants for each of the two exposure duration test trial blocks. A 3 (ITU) x 2 (Order) x 2 (Exposure duration) analysis of variance was performed with the only within-subjects factor being exposure duration. Two subjects were included in each cell of the factorial arrangement of between-subject factors. The only significant effect was for the Order by ITU interaction, F (2, 6) = 16.98, $p < .005$. The use of Duncan's multiple range test revealed that subjects performed significantly higher ($p < .05$) on both exposure duration conditions

together under the 2 ITU condition than under the 0 ITU and 5 ITU conditions when the 50 msec condition preceded the 30 msec condition. However, subjects performed significantly higher ($p < .05$) on the 5 ITU condition than on the 2 ITU condition when the 50 msec condition followed the 30 msec condition.

As in the previous study exposure duration did not significantly affect performance. Exposure duration was held constant at 50 msec for the remaining pilot experiments and the main study on psychiatric patients. There was no tendency for span of apprehension to be affected by the objective temporal predictability of stimulus onset as manipulated in the three ITU conditions.

PILOT EXPERIMENT 3

It was considered advisable for the main study on psychiatric patients that a method of assessing span of apprehension be developed which did not require the subject to recall and recite all of the elements that he had perceived. The stimulus elements which are recognized and then verbally labeled during a brief exposure to an array of elements are available for storage in active verbal memory. During the recall and recitation of the elements encoded, a response interference during recitation might interfere with a full verbal report of the number of elements actually encoded. It was believed that response

interference during recall might be particularly accentuated in schizophrenic patients. Therefore, it was decided to introduce after the iconic image of the display had faded, two letter consonants one of which had been present in the display to which the subject had been exposed. The subject would then be instructed to select which of the two consonants he recognized as being present in the display of letters he had just encoded. We then sought to develop a post-stimulus recognition measure of span of apprehension which did not require the recitation and full report of the consonants which had been perceived. Furthermore, such a method would allow a measure of span expressed in units comparable to the selective recognition target-letter measure. The only difference would be that in the selective recognition task the subject knows which of two target letters he is attending for prior to stimulus onset and these two target letters are the same for all of the trials. On the other hand, in the post-stimulus span of apprehension task the subject receives a set of two alternative letters which is not known until after the stimulus has been exposed and which varies from trial to trial. Thus he can only maximize his performance by perceiving as many elements as possible during exposure to the letter display.

To the above end it was necessary to assess the length of iconic sensory memory for the exposure duration and illumination values to be employed in the main study in order

that the post-stimulus alternatives not appear until the iconic image had completely faded.

Method

Subjects

Another sample of the same population of undergraduate students described in pilot experiment 1 was used for this study. An exception was that two of the students were known to the experimenter and participated without receiving class credit. Ten students were tested. There were two males and eight female subjects. The mean age of the ten students was 19.5 years with a range of 18 to 24 years old. All of the students had 20/20 corrected near visual acuity. The session took approximately two hours including several long breaks.

Design

The design was patterned after that of Sperling (1960). The independent variable was the time in seconds which a tone, indicating which of three rows of consonants the subject was to perceive and remember, preceded or followed the offset of the letter display. A simple full-report condition was also included. The independent variable was given in the same ascending order to all subjects. The dependent measure was the proportion of letters correctly reported in the correct display position.

Apparatus

The stimulus displays consisted of arrays of consonants constructed as follows: an IBM Selectric typewriter with a number 10 Orator element was used to type upper-case consonants on white, unlined 3x5 in. index cards. Cards were mounted on Masonite boards as described in pilot experiment 1. Ten sets of cards were constructed. Each set consisted of three practice trials and 12 test trials. On each card each display of letters consisted of three rows with three consonants in each row. For each stimulus card, nine consonants were randomly drawn without replacement from the 21 consonants of the alphabet (including the letter Y). They were then randomly allocated to the nine positions in the 3x3 matrix.

The displays were viewed in the same fashion described in pilot experiment 1 with the exceptions which follow. Because this procedure (Sperling, 1960) requires the subject to utilize and respond according to visual-spatial information, it was found necessary to increase the retinal angle subtended by the letter displays in order to replicate the iconic memory phenomenon discovered by Sperling. Large 11.3 cm magnifying lenses were placed at an appropriate distance in front of the stimulus arrays and the fixation dot. The framing arrangement and lighting in the tachistoscope made the presence of these lenses undetectable to the subject.

The 3x3 matrix on consonants covered an area which subtended a visual angle 2° 15' (.0394 rad) wide by 2° 49' (.0492 rad) high. Each letter subtended a visual angle 18' 3" (.0052 rad) wide by 36' 6" (.0105 rad) high. The fixation dot subtended a visual angle of 9' (.0026 rad). The stimulus and fixation fields consisted of a rectangle of illumination framed by a completely dark surround. The framed visual field covered an area which subtended a visual angle of 7° 19' (.1278 rad) wide by 6° 6' (.1065 rad) high. The stimulus field had a luminance of 6.0 ftl. The fixation field had a luminance of 1.5 ftl. Filters were employed as described in pilot experiment 1.

After the card was inserted into the tachistoscope the experimenter indicated that he was ready. The trial was initiated when the subject pressed a button which automatically triggered the onset of the stimulus display .5 sec after the button press. This delay was controlled by a Model 500 Western Bio-research Preset timer. The stimulus display appeared for an exposure duration of 50 msec. For the partial-report conditions an indicator tone of 76 db. produced by an audio oscillator instructed the subject as to which of the three display rows to attend to. Attention to the rows was indicated as follows: top row, 2200 Hz; middle row, 540 Hz; bottom row, 165 Hz. The indicator tone lasted for a duration of .5 sec. For the partial-report conditions the subject's button press not only triggered the .5 sec delay and stimulus onset; it also

triggered a timer which controlled the time of onset of the indicator tone. With this arrangement the following delays between offset of the 50 msec stimulus display and onset of the .5 sec indicator tone were employed: - .10 sec, 0 sec, + .15 sec, + .30 sec, + .50 sec, + 1.00 sec, + 2.00 sec, + 3.00 sec, and + 4.00 sec. Training with the indicator tones used an indicator tone onset which preceded the offset of the stimulus display by .55 sec, i.e. a delay of - .55 sec. This was accomplished by the button press automatically triggering the indicator tone and the .5 sec prestimulus onset delay. Indicator tone-onset delays and tone duration were controlled by Model DT203 Western Bio-research Indicating Preset timers regulated by a Western Bio-research Model DT101 clock.

Procedure

Each subject was given a standard set of instructions. First the subject was familiarized with the nature of the displays of consonants and examples of displays were shown at .5 sec and 50 msec exposures.

Full-report procedure. This condition was received first by all of the subjects. The subject was instructed simply to try to perceive and remember as many of the consonants and their locations as he could. He was told to report these letters by filling in the appropriate letters in a grid which was placed in front of him under the tachistoscope viewer. He was instructed to fill-in all of the

nine spaces in the grid with nine different consonants even if he had to guess at some of them. The subjects button-press initiated the 50 msec stimulus exposure .5 sec after the press. The procedure was tried twice and then three practice trials were given. This was followed by 12 test trials.

Partial-report procedure. The subjects were instructed that in this procedure everything would be the same as it was before except that on each trial they would hear a tone which would indicate which of the three rows they were to attend to and report. They were instructed to indicate on their grid the three consonants and their locations in the row that had been indicated by the tone. The correspondence between the three tones and the three rows of the letter display was demonstrated. They were told not to try to guess which row would be indicated but to wait until the indicator tone had sounded to focus their attention on a particular row of consonants.

Forty training trials were then given with the tones preceding the offset of the letter display by .55 sec, a delay of - .55 sec. This was followed by three practice and 12 test trials at each of the delay conditions in ascending order for all subjects as follows: - .10 sec, 0 sec, + .15 sec, + .30 sec, + .50 sec, + 1.00 sec, + 2.00 sec, + 3.00 sec, and + 4.00 sec. For each set of 12 test trials each of the three target rows occurred exactly four

times. A different random permutation of the sequence of target-row selections was employed for each of the delay condition trial blocks. The three practice trials for each condition contained one of each of the target rows, separately permuted for each of the delay conditions. The same ascending presentation of the delay conditions within each subject was recommended by Sperling (1960) as giving the best estimate of the decay of iconic sensory memory. The rationale given for the partial-report procedure is that as long as information is available in iconic memory the indicator tones will allow the subject to selectively encode the letters in the row which was been cued. As long as the icon is still present when the tone sounds, the proportion of correctly identified letters for the cued row will exceed the proportion correct under the full-report condition.

Results

The dependent variable used was the proportion of correctly reported consonants in the correct location on the grid. The proportions are based on three possible consonants in the partial-report conditions and nine possible consonants in the full-report condition. A one-way repeated measure analysis of variance was performed using the nine delay conditions and the full-report condition. The effect of delay including the full-report condition was highly significant, $\underline{F}\ (1, 9) = 15.29$, $\underline{p} < .005$ conservative test. The exact same significance level was achieved with

an arcsin transformation of the data.

Dunnett's test comparing each of the delay condition means (partial-report conditions) with the full-report mean was performed for the original and transformed data since the comparisons of interest were those indicating at what delay interval the subjects were no longer able to profit from the partial-report procedure. The significance of these $\underline{t}$ values was evaluated using one-tailed tests and the nonconservative number of degrees of freedom. These tests indicated that subjects performed significantly higher ($\underline{p} < .05$) in the partial-report conditions as compared to the full-report condition up to but not including the + 3.00 sec delay condition. A .5 sec allowance was made for the duration of the indicator tone. It was thus determined that the iconic sensory memory image may not have fully disappeared until 3.5 sec had elapsed since stimulus offset. On this basis a 3.5 sec delay from stimulus offset was employed in the post-stimulus recognition procedure. Figure 3 shows the decline in partial-report performance as the delay of the indicator tone increases. As can be seen iconic memory, as measured here, decays rapidly up to one sec after stimulus offset and then levels off and drops to full-report level of performance.

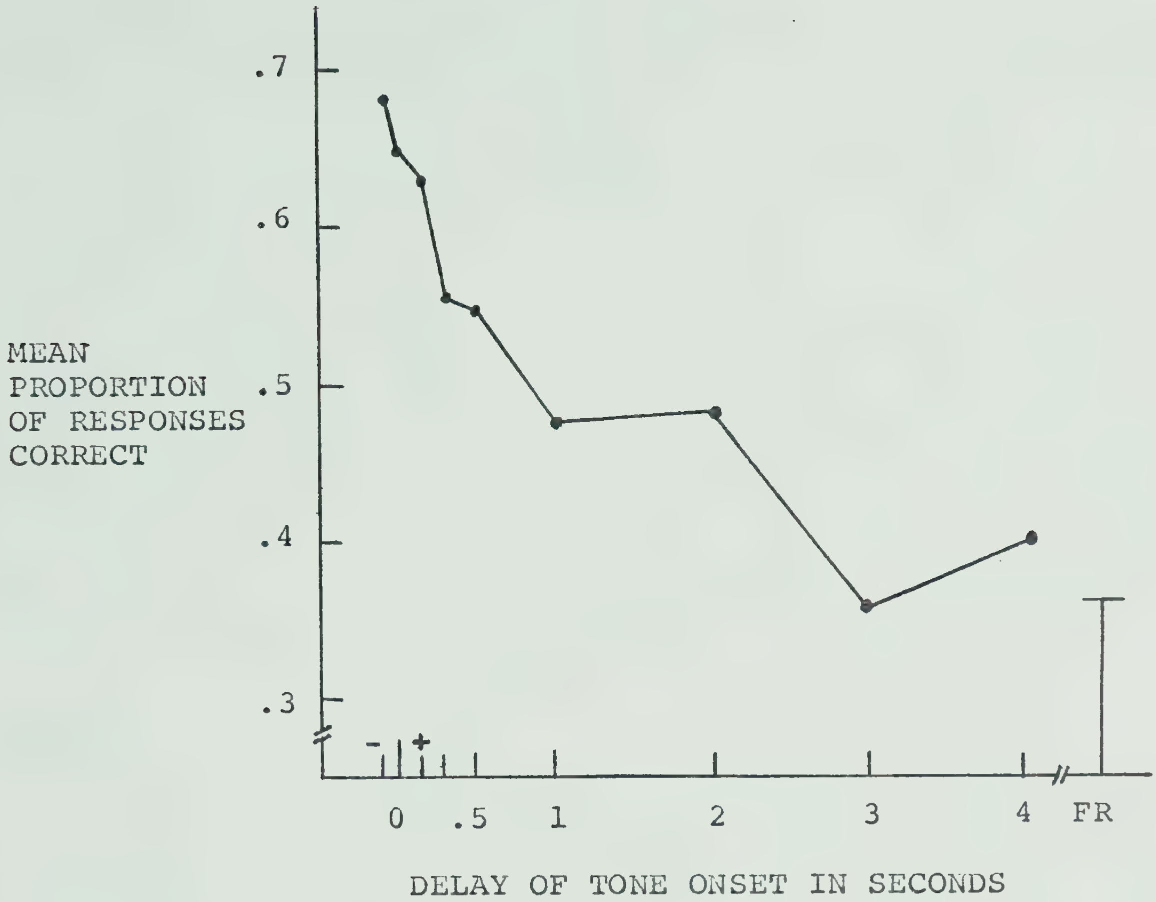

Figure 3. Proportion of correctly reported consonants in the correct location as a function of delay of indicator tone from stimulus offset and the full-report (FR) condition.

PILOT EXPERIMENT 4

On the basis of pilot experiment 3 the post-stimulus recognition procedure was developed. The subject was to perceive and remember as many consonants as he could and then select which of two letters which appeared afterwards, below the screen, he recognized as a letter present in the display he had just seen. This experiment was designed to find out whether subjects would perform at above chance levels using the new procedure and to examine the effect

of ITU on span of apprehension as measured by the new method.

Method

Subjects

A different sample of the same population of undergraduate students, described in the previous experiments, was tested. Six males and six female students were tested. The mean age of the 12 students was 19.4 years with a range of 17 to 28 years old. All of the subjects had 20/30 or better corrected near visual acuity.

Design

The dependent variable was the number of correct recognitions of the pairs of post-stimulus alternatives. The independent variable was the ITU. A randomized groups design was employed with four subjects (two males and two females) being randomly assigned to each of the three ITU conditions.

Apparatus

The set-up for this experiment is exactly the same as that of pilot experiment 2 with the exception that only 50 msec exposure durations were used and that the post-stimulus method rather than the recall method was used. The stimulus materials are the same ones used in pilot experiment 2. In the present experiment 16 practice trials and 64 test trials were given. For each of the displays one of the eight consonants was randomly selected for inclusion as one of the

post-stimulus alternatives. The second of the pair of post-stimulus alternatives was randomly selected from the 13 consonants which were not included on the stimulus card. The only restriction was that the correct post-stimulus alternative occur twice in each of the 16 locations in the imaginary 4x4 matrix of letters for two 32-card blocks of the 64 test-trial cards. There was no restriction on the location of the letters in the 16 practice trial cards. All subjects received the stimulus materials in the same order. The warning tone initiation, ITU conditions, and automated sequence of the stimulus event was the same as that used in pilot experiments 1 and 2. At the offset of the stimulus a small relay, packed in a box stuffed with insulation material, was triggered. This relay triggered the timers which controlled the 3.5 sec delay of post-stimulus alternatives and the 5.0 sec exposure of the post-stimulus alternatives. Two Western Bio-research Model DT203 Indicating Preset timers controlled these time intervals. They were regulated by a Western Bio-research Model DT101 clock.

Arrangement of the post-stimulus alternatives. These alternatives were presented in pairs. The letters were arranged inside the tachistoscope directly in front of and below the first of two framing units in the stimulus channel. There were three rows of seven consonants each arranged in alphabetical order. Consonants were upper-case bold opaque

letters embossed on small semi-transparent light covers. Each circle of light subtended a visual angle 1° 9' (.0202 rad) and had a luminance of 1.5 ftl. Each letter subtended a visual angle of 29' 15" (.0085 rad) square. The total array of 21 lights subtended an area 13° 50' (.2414 rad) wide by 5° 25' (.0946 rad) high. At the beginning of each trial the two alternatives were preset, using a switch board, by the experimenter and automatically lit up 3.5 sec after the stimulus offset. The light filters in between the stimulus display and the bank of post-stimulus lights prevented any illumination of the stimulus materials when the two post-stimulus lights were on.

Procedure

The same standard set of instructions was given to all subjects. First the nature of the stimulus materials was explained. The subject was told that on each trial he was to perceive and remember as many of the eight consonants as he could. Two examples were shown at .5 sec exposure durations. Then the subject was told that on each trial two letters would appear below the screen a short time after the display of letters had disappeared from the screen. He was instructed, "Only one of the two letters will have been present in the eight-letter array that flashed. You are to select, at the end of each trial, which of the two letters was present in the eight-letter array you saw." The procedure was practiced twice at a 5 sec, .5 sec and 50 msec

exposure duration. For each of these trials, the subject was shown the display of letters again after his response and he was shown that the correct letter had been present in the display. The ITU procedure was introduced as outlined in pilot experiment 1. The total procedure including the ITU condition was practiced twice. Then the eight practice trials and 64 test trials were given. A long break was given after 32 test trials. Smaller breaks were given every 16 test trials.

Results

The measure of the dependent variable was the number of correct post-stimulus-pair choices. A one-way randomized groups analysis of variance was performed with four subjects (two males and two females) in each cell. There was no significant effect of ITU, $F > 1$. Each of the means for the three ITU conditions significantly exceeded the chance level of 50% correct responses ($p < .01$, one-tailed). This small study indicated that the objective temporal predictability of stimulus onset is not a determining factor in span of apprehension performance as measured by this post-stimulus recognition method. These findings agree with those of pilot experiment 2 in which a recall method was employed. It was noted that subjects found this new method to be far less laborious and frustrating than the recall method. It was decided to employ this new method

in the main study on psychiatric patients.

SUMMARY OF THE RESULTS OF THE PILOT STUDIES

Pilot experiment 1 provided some evidence for a reduced selective recognition of target letters when the onset time of the stimulus display was highly unpredictable (5 ITU) as compared to zero objective temporal uncertainty (0 ITU). This obtained only for the eight-element array condition. It was therefore decided to employ an array size of eight consonants for the main study. Furthermore, it was believed that the use of eight-element arrays would lessen the chances of ceiling effects in the main study. There was no indication of an effect of ITU on span of apprehension performance using either the recall method (pilot experiment 2) or the post-stimulus recognition method (pilot experiment 4). Pilot experiments 1 and 2 revealed no statistically significant differences between 50 msec and 30 msec exposure durations for either selective recognition or span of apprehension scores. Therefore, it was decided to hold exposure duration constant at 50 msec for the main study. Pilot experiment 3 provided an estimate of the post-stimulus latency time for complete decay of iconic sensory memory. This estimate was a latency of no greater than 3.5 seconds. This estimate, based on the exposure duration and luminance values employed in the main study, provided the data required for the introduction of

a pair of post-stimulus alternatives as soon as possible after iconic memory had faded. The post-stimulus recognition measure of span of apprehension does not require the subject to fully recall and recite all of the letters that he has perceived on a particular tachistoscopic exposure trial. He simply selects which of two post-stimulus letter cues he recognizes as having been present in the array that he has just viewed. This method is described in pilot experiment 4. Pilot experiment 4 revealed above-chance performance levels using the post-stimulus recognition measure of span of apprehension. Subjects found this procedure to be far less tiresome and frustrating when their verbal reports were compared to subjects tested under the recall procedure of pilot experiment 2. The post-stimulus recognition procedure was employed as a measure of span of apprehension in the main study in order to avoid the possibility of response interference during recall.

During the pilot experiments many subjects complained of a sense of subjective strain which they attributed to the horizontal narrowness of the stimulus field framing arrangement. As a result of these complaints the horizontal frame dimensions were widened for the main study. The experience of running the subjects in the pilot experiments allowed for the elimination of virtually all equipment failures and provided the training needed for the smooth running of subjects in the main study.

CHAPTER III

MAIN STUDY

The main study was carried out on psychiatric patients at Alberta Hospital, Oliver. The study was divided into two separate experiments employing the same subjects. The first experiment was patterned after the pilot studies and involved the assessment of selective perceptual recognition and span of apprehension at various levels of the objective temporal predictability of stimulus onset for briefly exposed visual displays of letters. The second experiment involved the assessment of sensory-motor synchronization. These two experiments were both carried out on a group of psychiatric patients with a confirmed diagnosis of schizophrenia and a second group of psychiatric patients with nonschizophrenic diagnosis. Due to the scarcity of newly admitted or re-admitted relatively non-medicated schizophrenic patients with a minimum amount of total life psychiatric institutionalization, the testing of psychiatric patients took over one and one-half years. After the testing of psychiatric patients was completed the same two experiments were conducted on a reference group of male undergraduate students at the University of Alberta, Edmonton.

PERCEPTUAL EXPERIMENT

Method

Subjects

Thirty-two male schizophrenic patients and 32 non-schizophrenic male psychiatric patients were tested in both experiments as they became available at the hospital. After testing at the hospital was completed, 32 male undergraduate university students were tested with the same experimental set-up at the University of Alberta. The students came from the same basic population as those described in pilot experiment 1. Henceforth, the non-schizophrenic psychiatric patients will be referred to as the psychiatric controls. The means and standard deviations for age and education are given below in Table 1.

Table 1

Age and Education Data for the Three Subject Groups

Group [a]	Age		Education	
	Mean	SD	Mean	SD
Schizophrenics	32.69	10.44	10.22	2.92
Psychiatric Controls	27.03	7.23	10.94	1.56
Students	20.22	5.36	13.60	1.01

[a] n = 32 for each group.

The two patient groups did not significantly differ with respect to education, t (62) = 1.23, p = .30 two-tailed test. Schizophrenic patients were significantly, though slightly, older than the psychiatric controls, t (62) = 2.53, $p < .05$ two-tailed. Statistical tests were not carried out on the differences between the patient groups and the students since the students were deliberately picked as a more homogeneous younger and better-educated reference group. The student group was included in order to find out how a sample which would be expected to show a highly efficient level of performance would actually perform relative to the psychiatric patients. The students are not considered to be a proper normal control group. Only one of the schizophrenic patients was left handed and two of each of the other groups was left handed. All students had 20/30 or better corrected near visual acuity as measured by an eye chart. A breakdown in terms of marital status for the three groups is given in Table 2.

Table 2

Frequency Distribution of Marital Status Categories for the Three Groups

Group[a]	Marital Status			
	Single	Married	Separated	Divorced
Schizophrenics	18	8	4	2
Psychiatric Controls	23	5	2	2
Students	29	2	0	1

[a] n = 32 for each group.

Each patient was first individually interviewed by the author and then individually tested as soon as possible thereafter. The testing session for the two experiments lasted about two hours with small breaks and one long break. The author served as the experimenter. He attempted to test every available patient who met the selection criteria outlined in the sections that follow. It was necessary to develop a good rapport and sense of trust with the psychiatric patients, especially the schizophrenic patients. The experimenter assumed the role of a warm therapeutically oriented clinical psychologist who was interested in giving the patient some important tests of perception. Most of the patients considered the tests to be a part of the normal psychometric routine for persons newly admitted to the hospital. No patient was coerced into taking the tests. Patients who inquired were told that these tests were part of a study of the way that people who came to the hospital perceived the world around them. Each patient was related to with a genuine sense of respect and empathy. Prolonged discussions about the patient's experiences and problems were avoided prior to the testing and during the breaks. Only as much was discussed as seemed necessary for the author to maintain a receptive empathic rapport with the patient.

Hospitalization. No patient was tested who had collectively spent more than three years in a psychiatric ward or institution. Data as to number of psychiatric admissions (including the present admission), length of total life psychiatric hospitalization, and time elapsed since first psychiatric admission, and the number of days elapsed until testing after the present admission are given in Table 3. Although the schizophrenics had significantly more total life psychiatric hospitalization than did the psychiatric controls, the mean life hospitalization length of 179.72 days places these patients at a very low level of institutionalization when compared to the large number of studies using schizophrenic patients with over three years of continuous psychiatric institutionalization. For the schizophrenics an average of slightly over five years had elapsed since the first psychiatric admission. However, this distribution was positively skewed with 13 of the 32 schizophrenics having less than three years elapsed since the first admission. The two commonly used cutoff points for specifying a schizophrenic patient as acute are less than two years and less than three years since first admission (Neale & Cromwell, 1970). Using the two year cutoff point, 11 schizophrenics out of 32 would be placed in the acute category. Using the three year cutoff point, 13 schizophrenics out of 32 would be placed in the acute category with one additional schizophrenic who had exactly three years elapsed since his first admission.

Table 3

Hospitalization Data for the Two Patient Groups

Group	Number of Psychiatric Admissions		Total Life Psychiatric Hospitalization in Days		Time Elapsed in Days Since First Psychiatric Admission		Number of Days Elapsed Since Present Admission Until Tested	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Schizophrenics	3.59[a]	2.69	179.72[b]	231.22	1951.13[c]	1984.68	2.97[d]	2.53
Psychiatric Controls	2.12[a]	1.26	59.97[b]	103.74	572.59[c]	989.47	3.66[d]	5.25

[a] $t\ (62) = 2.80$, $p < .01$, two-tailed.

[b] $t\ (62) = 2.67$, $p < .01$, two-tailed.

[c] $t\ (62) = 3.52$, $p < .001$, two-tailed.

[d] $t\ (62) = 0.67$, $p = .60$, two-tailed.

Medication. No patient was tested who had recently undergone extensive antipsychotic medication therapy, i.e. phenothiazines, haloperidol, lithium carbonate, antidepressants. No subject was tested who had recently undergone electroconvulsive therapy (ECT) For most of the duration of the study a selection criterion of at least six weeks since the last antipsychotic medication was used. However, as subjects became scarce a number of patients were tested who had stopped medication on their own from two to four weeks prior to admission or who had not taken medication for over six weeks but were given a few doses upon admission with a sufficient medication recovery period prior to testing. It was judged that none of these patients were under the influence of antipsychotic medication at the time of testing. Only one patient, diagnosed schizophrenic, was on antiparkinsonian medication at the time of testing.

Of the 32 schizophrenic patients, 21 had not taken any antipsychotic medication for over six weeks prior to the time of testing. One schizophrenic had not taken antipsychotic medication for four weeks and another for two weeks. For the remaining 9 schizophrenics medication was as follows: 6 had less than 200 mg average daily dose for 1 to 2 days with from 1 to 6 days allowed for recovery; 3 had from 200 to 375 mg average daily dose for 1 to 2 days with 3 to 10 days allowed for recovery. Dosage levels reported above are expressed in terms of equivalent chlorpromazine

dosage level based on a table of equivalents (Hollister, 1970). Of the 32 psychiatric controls 27 had not taken any antipsychotic medication for over six weeks prior to the time of testing. One psychiatric control had not taken any antipsychotic medication for one week. For the remaining 4 psychiatric controls medication was as follows: 2 had less than 200 mg average daily dose for 1 to 4 days with 3 days allowed for recovery; 2 had from 200 to 500 mg average daily does for 1 day with 2 to 5 days allowed for recovery. Of the 32 schizophrenic patients 18 were on small doses of a minor tranquilizer (diazepam) and/or sedatives prior to the time of testing. Only 6 schizophrenic patients had taken a sedative the night before testing. Of the 32 psychiatric controls 18 were on small doses of a minor tranquilizer (diazepam or chlordiazepoxide) and/or sedatives prior to the time of testing. Only 6 psychiatric controls had taken a sedative the night before testing.

None of the psychiatric controls were on antidepressant medication or lithium carbonate at the time of testing. Two schizophrenic patients and three psychiatric controls had a history of hallucinogenic or amphetamine drug abuse. None of these subjects were under the influence of these drugs at the time of testing. The low rate of patients who were given any antipsychotic medication at admission was made possible by requesting the psychiatrists to delay the commencement of drug therapy for a few days until testing

had been completed.

<u>Diagnostic information</u>. The schizophrenic patients had all been given a carefully considered diagnosis by a psychiatrist or in seven cases a psychiatrically trained physician. After experimental testing was completed the diagnostician completed a symptom check list (see Appendix A). On a clinical basis 29 were judged to be process schizophrenics, 2 reactive, and 1 undecided. "Mild" and "moderately disintegrated" were the most commonly checked categories with only six schizophrenics placed in the "severely disintegrated" category. Break-down for classical type of schizophrenia was as follows: simple, 3; paranoid, 13; catatonic, 3; hebephrenic, 2; undifferentiated, 11. For the 32 schizophrenic patients 28 were judged to have at least one positive Schneiderian symptom. Table 4 gives the frequency distribution of number of Schneiderian symptoms present for the 32 schizophrenic patients. Table 5 lists the eight Schneiderian symptoms and the number of schizophrenic patients reported to have each of the symptoms. It is clear from these data that the majority of the schizophrenic patients were actively experiencing the psychotic process.

Table 4

Frequency Distribution of Number of Schneiderian Symptoms Present for the Schizophrenic Patients

Number of Schneiderian Symptoms	Number of Schizophrenic Patients[a]
0	4
1	7
2	6
3	4
4	4
5	3
6	2
7	1
8	1

[a] Total $\underline{n}$ = 32.

Table 5

Number of Schizophrenic Patients Exhibiting Each of Schneider's Symptoms of the First Rank

Symptom	Number of Schizophrenic Patients [a]
Thought echo or thoughts spoken aloud	12
Hallucinatory voices speaking about patients in the third person	11
Hallucinatory voices in the form of a running commentary on the patient	7
Bodily hallucinations experienced as sensations produced by an external agent	9
Thought withdrawal, thought insertion or other influence on thought	13
Thought broadcasting	7
Delusional perception	18
Passivity experience in feeling, drives or volition	12

[a] For each symptom the maximum possible n was 32.

Of the 32 schizophrenics 30 were judged to have atleast one of Bleuler's four fundamental signs (Bleuler, 1950) (see Table 6). Table 7 shows the number of schizophrenic patients judged to have each of Bleuler's four fundamental signs of schizophrenia. As seen from Table 7, disorder

of association (formal thought disorder) and disordor of affect were the two most commonly reported signs. Flat and/or incongruent affect were the most commonly checked signs under the disorder of affect category. The number of schizophrenics found to have the other fundamental symptoms on the check list were as follows: 16, disorder of attention; 15, disorder of will; 10, ego disintegration; 9, schizophrenic dementia; 28, disorders of activity and behavior. Under disorders of activity and behavior "lack of initiative" (19 patients) and "incomprehensible behavior" (18 patients) were the most frequently checked subcategories.

Table 6

Frequency Distribution of Number of Bleuler's Four Fundamental Signs for the Schizophrenic Patients

Number of the Four Fundamental Signs	Number of Schizophrenic Patients [a]
0	2
1	2
2	10
3	15
4	3

[a] Total _n_ = 32.

Table 7

Number of Schizophrenic Patients Exhibiting Each of Bleuler's Four Fundamental Signs of Schizophrenia

Sign	Number of Schizophrenic Patients[a]
Disorder of association	20
Disorder of affect	30
Ambivalence	15
Autism	14

[a] For each sign the maximum possible _n_ was 32.

For the schizophrenic patients premorbid adjustment was measured using the Ullmann-Giovannoni (1964) self-report scale (see Appendix B). This scale contains 24 true-false items dealing with past and present social adjustment. The schizophrenic patients had a mean score of 13.22, _SD_ = 4.62. Using the commonly employed cutoff points of 0 to 12 poor premorbid adjustment ("process" schizophrenia) and 13 to 24 good premorbid adjustment ("reactive" schizophrenia), 14 schizophrenics would be classified as having poor and 18 as having good premorbid adjustment. Held and Cromwell (1968) found that schizophrenics' answers to the Ullmann-Giovannoni (U-G) item "I have been or still am married" predicted scores on the Phillips premorbid rating scale better than the total U-G score. Using this item, only, 18 schizophrenics were classified as having poor and

14 as having good premorbid adjustment.

Patients with organic or toxic disorders, senile dementias, severe and recent drug abuse, and the mentally retarded were not included as psychiatric controls for this study. Of the 32 psychiatric controls 11 had a primary diagnosis of depression (5 endogenous depression, 4 reactive depression, 2 chronic depression); 3 had a primary diagnosis of manic phase, manic-depressive psychosis; 1 hypomania; 1 paranoid psychosis; 13 had a diagnosis of personality disorder or inadequate personality (8 with a secondary diagnosis of anxiety state or depression); 3 had a primary diagnosis of anxiety state or anxiety neurosis.

Five schizophrenic patients were originally selected for inclusion in the study but were either too thought disordered or too disintegrated to understand the instructions and testing had to be discontinued. Ten schizophrenic patients and one psychiatric control refused to take the tests once in the experimental room. In most of these cases either an explicit delusional system was operating or the patient was too ambivalent to take any kind of decisive action. None of the above subjects were included in the two groups of 32 schizophrenic patients and 32 psychiatric controls tested for this final study. Testing was completed for all of the subjects in the final study.

Design

The dependent variables used were the number of correct responses on each of the two experimental tasks. Each subject received both perceptual tasks. The selective attention task required the subject to selectively recognize which of two target letters, "T" or "F", was present in a display of consonants briefly exposed in a tachistoscope. The span of apprehension task required the subject to perceive and remember as many consonants he could and then choose which of two letters that appeared afterwards was the letter present in the visual display he had just seen. These two tasks provided two different measures of perceptual functioning expressable in the same units of measurement and with equivalent chance levels of performance. Thus, quantitative comparisons could be directly made between performance scores on the two tasks. The design of the experiment was mixed factorial with the three intersubject factors: diagnostic group, interval of temporal uncertainty (ITU) of the time of stimulus onset, order of the two perceptual tasks; and with one intrasubject factor -- the two perceptual tasks. To summarize, the mixed factorial design was: 3 (Diagnostic group) x 4 (ITU) x 2 (Order) x 2 (Task), (the first three factors between subjects, the last factor within subjects).

Within each diagnostic group, four subjects were randomly assigned to each of the ITU x Order contingencies.[7] Each subject received the two perceptual tasks under the same ITU condition.

Apparatus

The stimulus displays consisted of arrays of consonants which were constructed as follows: Upper-case consonants were typed on a white, unlined 3x5 in. index card using an IBM Selectric typewriter with a number 10 Orator element. Cards were mounted on 12.8 x 24.3 cm Masonite boards for insertion and withdrawal from the tachistoscope. In order to widen the visual field, strips of the same index card material were fixed to the masonite boards and

---

[7]For each of the two patient groups the subjects were randomly assigned to the eight possible ITU x Order contingencies by sampling the allotments with replacement for each subject. This procedure made it equally likely that a patient would be assigned to any of the contingencies independent of the allotments of patients already tested and hence prevented the experimenter from having any probabilistic knowledge as to which treatment a patient would receive when he was recruiting the patient. After approximately two thirds of the patients in each group had been tested the procedure was shifted such that the remaining subjects were given a random selection without replacement of the allotments needed to fill up each cell. The shift took place due to the scarcity of patients and the possibility that with the earlier procedure too many extra subjects would have to be tested and then randomly rejected in order that all of the cells would be filled. The use of the initial randomization procedure resulted in two extra schizophrenics being run and no extra psychiatric controls. For the students allotments were randomly sampled without replacement.

were fitted perfectly to the sides of the 3x5 in. cards. Two sets of cards were constructed, one set for each of the two perceptual tasks. Each set consisted of 16 practice trials and 64 test trials. For the selective attention task letters were allocated after the manner of Neale et al (1969). An imaginary 4x4 matrix of 16 letter spaces was located in the center of each card. Each array contained one and only one of the two target letters, a T or an F, plus seven distractor consonants; for the 64 test trials each of the two target letters appeared twice in each of the 16 possible matrix locations yielding a total of 32 test-trial cards with the letter T and 16 test-trial cards with the letter F. The 16 practice-trial cards contained 8 cards with the letter T and 8 cards with the letter F. The location of the target letters was independently allocated for each of the 16 practice-trial cards without any restrictions. For each of the stimulus cards seven non-target distractor consonants were randomly drawn without replacement from the remaining 19 consonants of the alphabet (including the letter Y). They were then randomly allocated to seven of the positions remaining in the imaginary 4x4 matrix.

For the span of apprehension task letters were allocated after the manner of Cash, Neale and Cromwell (1972). An imaginary 4x4 matrix of 16 letter spaces was located in the centre of each card. For each of the stimulus cards,

eight consonants were randomly drawn without replacement from the 21 consonants of the alphabet (including the letter Y). They were then randomly allocated to eight of the positions in the imaginary 4x4 matrix. Then for each of the displays one of the consonants was randomly selected for inclusion as one member of the pair of post-stimulus alternatives for that display. The second of the post-stimulus alternatives was randomly selected from the 13 consonants which were not included on the stimulus card. The only restriction was that the correct post-stimulus alternative appear four times in each of the 16 locations in the imaginary 4x4 matrix of letter spaces over the 64 test trials. There was no restriction on the location of the correct post-stimulus alternative for the 16 practice-trial cards. One new random permutation of each of the two sets of test-trial cards was performed after the cards were typed. The same two permutations of practice and test trials for the selective attention and span of apprehension sets were given to all of the subjects.

The imaginary 4x4 matrix covered an area which subtended a visual angle 1° 46' (.0308 rad) wide by 2° 5' (.0363 rad) high. Each letter subtended a visual angle 8' 28" (.0025 rad) wide by 16' 55" (.0050 rad) high. There was a border to border 23' 16" (.0068 rad) horizontal and 19' 2" (.0055 rad) vertical separation between the characters in the imaginary 4x4 array of letter spaces. In other words these are

the minimum inter-consonant separation distances possible for any given array. Figure 1 in the pilot experiment section gives an example of an array of consonants.

For both perceptual tasks the displays were presented in a Scientific Prototype Model 800E two-channel tachistoscope. The center of the pre-post stimulus fixation field contained a small black dot. The dot subtended a visual angle of 4' 14" (.0012 rad). The subject viewed the fixation field and stimulus arrays through a rubber face-rest viewer with his head covered by a black opaque soft cloth which was attached to the viewer. The stimuli and fixation dot were at a respectively real and apparant distance of 81.3 cm from the subject. Both the stimulus and fixation fields consisted of a rectangle of illumination framed by a completely dark surround. The framed visual field covered an area which subtended a visual angle 5° 38' (.0983 rad) wide by 4° 57' (.0863 rad) high. All viewing was binocular. The fixation field had a luminance of 1.5 ftl. and the exposure field had a luminance of 6.0 ftl. All test and practice-trial stimuli were exposed for a duration of 50 msec. Kodak Wratten neutral density gelatin filters provided a reduction of luminance with the finer adjustments being made with the lamp controls on the tachistoscope. The use of filters avoided the possibility of any flicker that might occur during stimulus onset or flicker that might occur during stimulus offset with a

partially ignited bulb at the low setting necessary for filter-free attainment of the luminance values desired.

For the three ITU conditions the sequence of operations was as follows: After the card was inserted into the tachistoscope the experimenter initiated the trial sequence after the subject indicated that he was ready in response to the experimenter's indication that he, the experimenter, was ready. The experimenter triggered a Hunter Model 111-C Series D Decade Interval timer. This timer controlled the duration of a .4 sec warning tone of 2.5 kHz, at 65 db., delivered by a Sonalert tone device hidden under the tachistoscope. Warning tone offset initiated the preparatory interval preset for each trial. The preparatory interval was controlled by a Western Bio-research Model 500 Preset timer. When the preparatory interval had elapsed the tachistoscope was automatically triggered and the onset of the letter-display exposure was instantaneously initiated. This ends the series of events for the selective attention task. For the span of apprehension task the offset of the 50 msec stimulus exposure triggered a small relay packed in a box with insulating material to minimize any sound. This relay triggered timers which controlled a 3.5 sec delay for the onset of the post-stimulus alternatives and the 5.0 sec exposure of the post-stimulus alternatives. Two Western Bio-research Model DT203 Indicating Preset timers controlled these time intervals. They were regulated by a Western Bio-

research Model DT101 clock. The post-stimulus alternatives were presented via lights arranged inside the tachistoscope directly in front of and below the first of two framing units in the stimulus channel. There were three rows of seven consonants each arranged in alphabetical order. Consonants were upper-case bold opaque black letters embossed on small semi-transparent light covers. Each circle of light subtended a visual angle of 1° 9' (.0202 rad) and had a luminance of 1.5 ftl. Each letter subtended a visual angle of 29' 15" (.0085 rad) square. The total array of 21 lights subtended an area 13° 50' (.2414 rad) wide by 5° 25' (.0946 rad) high. At the beginning of each trial the two post-stimulus alternatives were preset by the experimenter, using a switch board, and lit up 3.5 sec after stimulus offset. The light filters in between the stimulus display and the bank of post-stimulus lights prevented any illumination of the stimulus materials when the two post-stimulus lights were on. For both perceptual tasks the self-initiate condition led to the same sequence of events already described except that the subject pressed a button which directly triggered the Western Bio-research Model 500 Preset timer, which in turn triggered the onset of the stimulus display and the subsequent sequence of events. The timer was set at .1 sec which in effect caused the stimulus display to appear just as the subject had completed his squeeze of the button. There was no warning tone for the self-initiate condition. The barely audible relay click

which followed stimulus offset for the span of apprehension was also triggered during the selective attention task in order to match these two tasks on every possible variable. The barely audible clicks generated by the post-stimulus control timers were also left on during the selective attention task although the stimulus lights for the post-stimulus alternatives were, of course, turned off. In an attempt to match the inter-trial interval for the two tasks, the experimenter did not begin the next trial of the selective attention task until the "span of apprehension" timers had timed out.

Each subject was given both the span of apprehension task and the selective attention task under the same ITU condition or self-initiate condition he had been assigned to. For the 0 ITU condition the preparatory interval (PI) was held constant at 3.0 sec for all practice and test trials. For the 2 and 5 ITU conditions possible PI values were graded in .1 sec intervals ranging from 2.0 to 4.0 sec for the 2 ITU condition and 0.5 to 5.5 sec for the 5 ITU condition. PI was measured as the time interval between the offset of the warning tone and the onset of the 50 msec exposure of the stimulus display. Each subject received a different set of randomized PI values for the test trials under the 2 ITU and 5 ITU conditions and a different set for each of the two perceptual tasks. For the 2 and 5 ITU conditions PIs were randomly sampled with re-

placement for each of the 64 test trials and each of the 16 practice trials for each task. A computer generated a quasi-random sequence of PIs for each subject and each task. For each of the 2 ITU and 5 ITU conditions 250 PI sequences were generated. Then out of these 250, for each ITU value, 74 of the most rectangularly distributed sequences were selected. These two groups of 74 sequences also met the restriction that the mean PI for a sequence not deviate by more than $\pm$ .2 sec from the mean PI value of 3.0 sec and that the minimum and maximum possible ITU value each occur at least once in the sequence. PI sequences were then taken at random for each subject from the final stock of sequences just described. A different set of PI sequences was generated for the four sets of 16 practice trials given by the two ITU conditions (2 ITU and 5 ITU) and the two tasks (selective attention and span of apprehension). These sequences were selected to provide a wide range of PI values and were held constant.

Procedure

The two perceptual tasks were given after the subject had completed the tap-click timing task and had a short rest. The same general stimulus orientation instructions were given prior to each of the two perceptual tasks. In the general instructions the subject was oriented to the tachistoscope and the nature of the displays was described and shown using displays of all of the consonants in the alphabet

which were recited to the subject and a display of the five vowels which would never appear during the task. The complete set of instructions is given in Appendix C. Half of the subjects then received the selective attention task first and the other half received the span of apprehension task first. For the selective attention task subjects were told that one and only one of the eight letters that appeared in each display would be either a T or an F. The subject was told that he was to discover which of these two target letters, T or F, was present in each display he saw. A selective-attention set was further reinforced by the following statement, "We are not interested in how well you can see the other irrelevant letters that accompany the T or F. Simply focus your attention on whether a T or an F is present in the letter display. Then, tell me your answer." The equal random probability of the two target letters and the randomness of their location on the screen was emphasized. Two training trials at each of a 5 sec, .5 sec, and 50 msec exposure duration, in ascending order, were given with visual feedback as to the correctness of the subject's responses for each trial. Then the ITU condition or self-initiate condition the subject had been assigned to was explained and demonstrated. The relationship between the warning tone and the flash of the letter display was demonstrated as well as the range of possible onset times for the stimulus after the tone. For subjects in the self-initiate condition, the button press triggering of stimulus onset was practiced and it

was emphasized to him that he would be the person who initiated the flash of letters. The entire procedure was then practiced twice. For the ITU conditions, the experimenter said that he was ready at the beginning of each trial. The experimenter triggered the sequence of events after the subject indicated that he was ready. For the self-initiate condition, the subject triggered the exposure of the stimulus display and sequence of events whenever he felt ready after the experimenter indicated that he was ready. Sixteen practice trials were then given, followed by a five minute break, at the 50 msec exposure duration. Then 64 test trials were given at the 50 msec exposure duration. A five minute break was given at the end of each block of 16 test trials with a ten minute break at the end of the first 32 test trials. The intertrial interval varied with the individual subject's response rate, but on the average a latency of approximately 10 to 15 sec between the end of one trial and the beginning of the next was maintained. Subjects were instructed to hold a fixation on the dot from the time of their ready signal until the display of letters had disappeared. In order to use substitute cards for trials on which blinks occurred, the following instruction was given, "If the letter display fails to appear, please let me know."

For the span of apprehension task, the instructions were the same as for the selective attention task with a few exceptions as follows. After the general instructions

subjects were told that when each letter display appeared they were to try to see and remember as many of the letters as they could. They were told that after each display of letters had disappeared from the screen, two letters would appear below the screen. The post-stimulus lights were demonstrated to the subject as he was instructed, "After each display of letters disappears from the screen you are to choose which of the two letters that appears below the screen is the letter that was present in the letter display you saw on the screen. Then, tell me your answer." A large demonstration card was then shown to the subject the experimenter explaining and showing how one and only one of the pair of post-stimulus choices for each trial had been present in the letter display the subject had just seen. He was told that the more letters he could see and remember from the stimulus display the easier it would be for him to recognize which of the two post-stimulus alternatives had been included in the letters on the screen. It was emphasized that there was no way he could tell until the display had disappeared what the post-stimulus alternatives would be for each trial. Training with the span of apprehension technique as well as the introduction of the ITU condition followed the same pattern as described for the selective attention task. The same number of practice and test trials as well as breaks were given as is described for the selective attention task. The inter-trial interval was the same as that described for the selective attention task.

In-between the two perceptual tasks a long break of at least 15 minutes was given. Before the commencement of the second task (the span of apprehension or the selective attention task) instructions were given to the effect that although the second task would be similar to the first task in many ways it would be very different in other ways. The subject was told to forget about the previous task and that the experimenter would start over from the very beginning just as if the first task had never been given.

Results

The measure of the dependent variable was the number of correct target-letter recognitions for the selective attention task and the number of correct post-stimulus choices for the span of apprehension task. The two dependent measures were comparable both in terms of the range of the scores possible and the expected value of the score for chance-level performance. A 4 (3 ITU conditions and Self-Initiate) x 3 (Diagnostic Group) x 2 (Order of the Two Tasks) mixed factorial design analysis of variance was performed with all factors being between subjects except for the comparison between the two tasks which was within subjects. (see Appendix D). Four subjects in each group were randomly assigned to each cell of the factorial arrangement of between-subjects factors. A significant main effect was present for the diagnostic group factor, $\underline{F}$ (2, 72) = 39.59, $\underline{p} < .001$.

A significant main effect was also present for the selective attention vs. span of apprehension task factor, F (1, 72) = 244.48, $p < .001$. None of the other main effects and none of the interactions were statistically significant. The data was converted to proportions and the transformation $\emptyset = 2 \arcsin \sqrt{P}$ was performed as suggested by Winer (1962, p. 221). An analysis of variance was performed (see Appendix E). The conclusions and significance levels were the same as for those of the analysis using raw data with the exception of a significant ITU x Order x Task interacgion with the transformed data, F (3, 72) = 2.96, $p < .05$. This interaction was in the direction of a higher performance for the selective attention task when it was given first, except for the 5 ITU condition where this is reversed. This same interrelationship only slightly obtained for the span of apprehension task.

The results indicate no overall effect of the temporal uncertainty of stimulus onset on either selective attention or span of apprehension performance as manipulated with the ITU. There was no evidence for a differential effect of ITU for the different diagnostic groups on either selective attention or span of apprehension. The results show that subjects had high performance scores for the selective attention task as compared to the span of apprehension task. This difference remains constant for each of the three groups of subjects. Newman-Keuls tests were carried out for the

main effect of subject group with the same results using both the transformed and raw data. All paired comparisons were statistically significant at the $p < .01$ level. For both tasks students performed significantly higher than the psychiatric controls who in turn performed significantly higher than the schizophrenics. Figure 4 shows the contrast between performance on the selective attention task as compared to the span of apprehension task, expressed as the proportion correct out of 64 test trials, for the three subject groups. All of the means significantly exceeded the 50% chance level of responding ($p < .01$, one-tailed). The means and standard deviations for the attention and span data are presented in Appendix F.

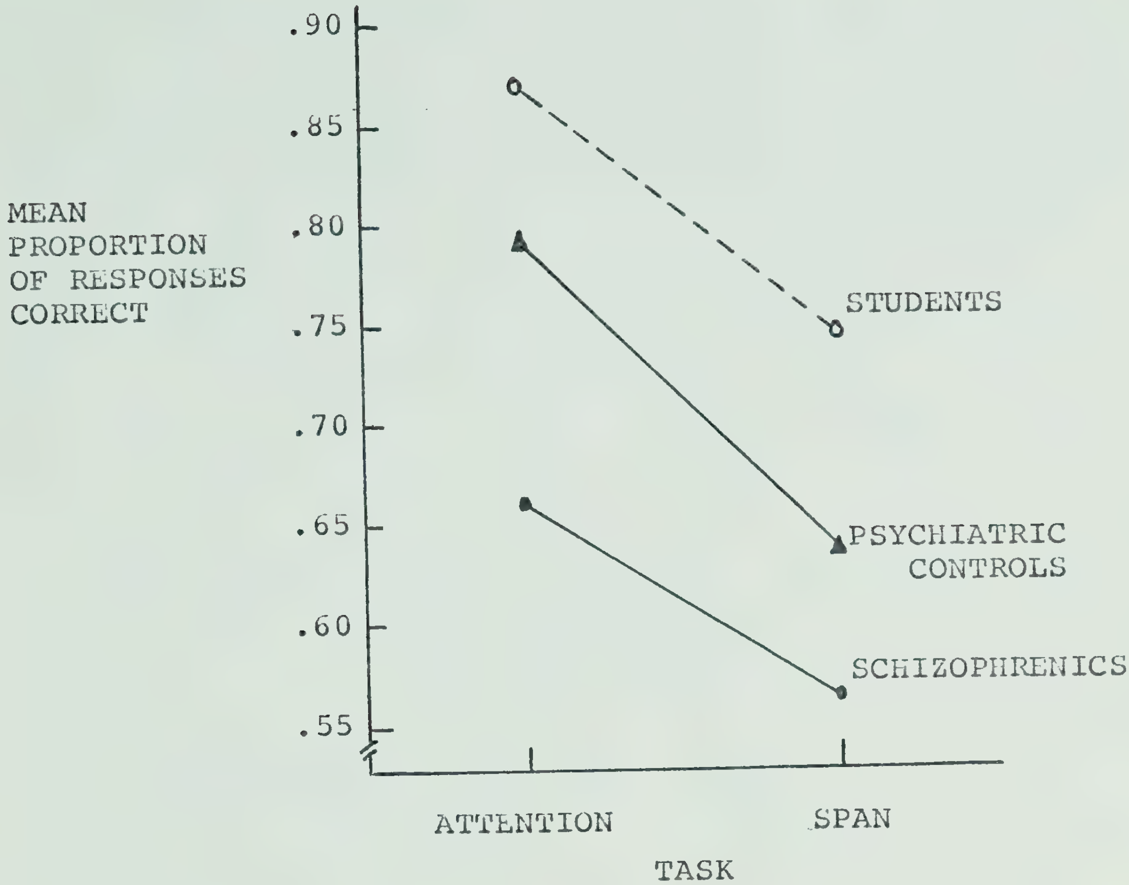

Figure 4. Mean proportion of responses correct as a function of task for the three subject groups.

In order to compare the scores on the first and the second half of the 64 test trials, t tests for correlated means were carried out for each of the two perceptual tasks within each of the three subject groups. None of these t tests were statistically significant. Thus, there was no evidence for either a practice or a fatigue effect across the test trials for either of the tasks within any of the subject groups. Pearson product-moment correlation coefficients were calculated for each of age and education with performance on each of the two tasks within each sub-

ject group. These coefficients are given in Table 8. Substitute trials were used when subjects revealed a probable blink interference by saying that the letter display had failed to appear. The mean number of such "blink" trials per subject was as follows: schizophrenics, *M* = .72, *SD* = 1.17; psychiatric controls, *M* = .94, *SD* = 2.29; students, *M* = .09, *SD* = 0.30. The fixed random sequence of substitute cards happened by chance to have more "T" than "F" cards among the first four cards. As a result the 50% value of 32 T stimulus cards for the 64 trials was varied. The mean numbers of T stimulus cards for the subject groups, taking substitution trials into account, were: schizophrenics, *M* = 32.47, *SD* = 0.84; psychiatric controls, *M* = 32.28, *SD* = 0.68; students, *M* = 32.12, *SD* = 0.34.

Table 8

Correlations Between Age, Education
Attention and Span Performance for
Schizophrenics, Psychiatric Controls and Students

	Span Task	Age	Education
Attention Task			
Schizophrenics	+ .44*	- .21	+ .25
Psychiatric Controls	+ .44*	- .22	+ .16
Students	+ .51**	- .59**	+ .07
Span Task			
Schizophrenics	--	+ .04	+ .08
Psychiatric Controls	--	- .22	+ .29
Students	--	- .40*	+ .08

*$p < .05$ two-tailed. **$p < .01$ two-tailed.

Response bias on the selective attention task was examined: The dependent variable was the number of "T" responses, calculated for each subject. The means and standard deviations of this measure was calculated for each of the subject Groups across the experimental conditions (see Table 9).

Table 9

Means and Standard Deviations for the Number of "T" Responses for Each of the Subject Groups

Subject Group [a]	Mean	SD
Schizophrenics	35.28	5.98
Psychiatric Controls	34.16	4.50
Students	33.47	3.51

[a] $n = 32$ for each group.

A one-way randomized groups analysis of variance was carried out. There was no significant difference between the three subject groups on the mean number of T responses, $F\ (2,93) = 1.18$, $p = .25$. This result indicates no significant difference in response-specific response bias for the three groups. All of the means in Table 9 significantly exceed the 50% chance level of response using the normal approximation to the binominal distribution to test the means for each group: $p < .05$ two-tailed, students; $p < .01$ two-tailed,

schizophrenics and psychiatric controls. However, these significant deviations are very small and could not have detracted much from the precision of the number of correct responses as a measure of selective-attention efficiency. The between-subjects variances for each of the three groups in the number of T responses provides a measure of response-nonspecific response bias within each group. Using both the Cochran and Hartley tests the variances were found to be significantly heterogeneous, $p < .05$ for both tests. The schizophrenics indicate the highest response-nonspecific response bias as a group followed by the psychiatric controls and students in that order. It was decided not to perform the corrections for response bias, suggested by signal-detection theory (Green and Swets, 1966), which assume that a receiver operating characteristic (ROC) curve describes the plot of hit rate (e.g. probability of a T response given a T target) against false alarm rate (e.g. probability of a T response given an F target). The assumed ROC curve is a linear function with a 45° slope and symmetrical about the negative diagonal when the hit and false-alarm rate axes are given as Z-score coordinates. There is no evidence as to the shape of the ROC curve for the present task. Authors such as Neale et al.(1966) have made statements implicitly in support of an ROC based corrected for the task utilized here and then they have proceeded to treat and transform the data as if the exact opposite, a right-wrong correction, were appropriate. The trans-

formations of Neale et al. (1969) were discussed in the introduction. Secondly, for the levels of response bias found here and the performance scores of our subjects an ROC based correction would not have changed the raw scores (number of correct responses) by more than one point (roughly .02 units if the proportion correct is used) for all but a few subjects where the change might have been as great as two or three points. Considering the variances and differences between the means of the subject groups, such a laborious and questionable correction procedure would not have noticeably affected the results.

Using the data for only those subjects tested under the 5 ITU condition, the effect of preparatory interval on selective attention and span of apprehension performance was determined. Within each subject the preparatory intervals were grouped into three equal class intervals as follows: 0.5 to 1.4 sec; 1.5 to 2.4 sec; 2.5 to 3.4 sec; 3.5 to 4.4 sec; 4.5 to 5.5 sec. The dependent variable was the proportion of correct responses for each subject within each preparatory interval class for each of the two perceptual tasks. A 3 (Diagnostic Group) x 2 (Selective Attention vs. Span of Apprehension Task) x 5 (Preparatory-Interval Class) analysis of variance was carried out with diagnostic group being the only between-subjects factor. There were eight subjects in each of the diagnostic groups. The same main effects for diagnostic groups and the contrast between

the two tasks emerged as were found in the analysis described earlier which used all of the data. A statistically significant diagnostic group x task x preparatory interval interaction was found, $\underline{F}$ (8, 84) = 2.15, $\underline{p} < .05$. This interaction was not statistically significant when the conservative number of degrees of freedom were used. The interaction was in the direction of each of the two patient groups (schizophrenics and psychiatric controls) showing a uniform performance level on the selective attention task except for a drop in the mean score at the 3.5 to 4.4 sec preparatory interval range with the students showing the reversal, i.e. an increase in the mean score at the 3.5 to 4.4 sec range. On the span of apprehension task the two patient groups showed an increase in the mean score at the 1.5 to 4.4 sec range while the students had an isolated peak at the 1.5 to 2.4 sec range. These curious results are not caused by the equipment, such as the timers, malfunctions etc. The experimenter remained quiet and relaxed during the preparatory intervals. These peaks and valleys may reflect some kind of oscillation of vigilance with either drops or compensatory increases after the subject has waited for four seconds for the stimulus to onset.

Using the data for subjects tested under the 5 ITU condition the effect of the difference between the preceding preparatory interval minus the preparatory interval, for each trial, on selective attention and span of appre-

hension performance was examined. Within each subject these differences were calculated and then grouped into three class intervals as follows: - 5.0 sec to - 1.7 sec; - 1.6 sec to + 1.6 sec; + 1.7 sec to + 5.0 sec. A positive difference indicates that the preceding preparatory interval was larger than the present preparatory interval for a given trial and a negative difference indicates the reverse. A 3 (Diagnostic Group) x 2 (Selective Attention vs. Span of Apprehension Task) x 3)Preparatory-Interval-Difference Class) analysis of variance was carried out. The diagnostic group factor was the only between-subjects factor, with eight subjects in each group. The dependent variable was the proportion of correct responses within each class interval for each subject for each of the two perceptual tasks. For the main effect of the difference between the preceding preparatory interval minus the present preparatory interval, as well as all of the interactions with this factor, there were no statistically significant differences, the F ratios were all less than unity.

For the schizophrenic patients, Pearson product moment correlations were calculated between scores on the Ullmann-Giovannoni (U-G) premorbid adjustment scale and attention and span scores. The correlation between premorbid adjustment and attention scores was near zero (r = + .02). The correlation between premorbid adjustment and span was + .31 (p < ,05, one-tailed test). This correlation indicated

that better premorbid adjustment was associated with a higher span of apprehension.

Summary of Results for the Perceptual Experiment

The main finding was that all three of the subject groups (schizophrenics, psychiatric controls and students) show the same increase in performance on the selective attention task when compared to the span of apprehension task. Schizophrenics evidence the same drop in performance on both perceptual tasks when compared to the psychiatric controls who in turn had lower scores on both tasks than did the students. These results argue against the presence of an attention-specific deficit in schizophrenia. Since the two patient groups significantly differed on mean age, the lower performance by the schizophrenics on the perceptual tasks as compared to the psychiatric controls may be attributable to the significantly higher age of the schizophrenic group. Although not statistically significant, there was a negative correlation between age and attention scores within both patient groups. There was a negative correlation between age and span scores within the psychiatric control group, but a near zero correlation within the schizophrenic group. The small size of these correlations suggests that the confounding of mean age with patient group is not likely to account for the differences between the two patient groups on perceptual performance. It might be thought that these correlations are artificially

lowered due to restrictions on the range of age and perceptual scores within the groups. However, the range of the ages for the schizophrenic group includes within it the entire range of age for the other two groups with the exception of two students who were one year younger than the youngest schizophrenic. Of course, restrictions within groups on the range of the perceptual task scores would also lower the estimate of the correlation between age and perceptual performance. However, it was decided not to pool the groups in order to perform correlations since potentially real intergroup differences on perceptual performance would give an inflated estimate of the correlations between age and attention and span, due to the confounding of age with the subject-groups factor. The absence of an effect of the temporal predictability of stimulus onset (ITU) for any of the three subject groups offers no evidence that perceptual set synchronization is a critical factor in the selective perception of visual displays as suggested by pilot experiment 1. The present experiment yielded no evidence in support of a perceptual synchronization deficit explanation for the lower performance by schizophrenics on selective attention or span of apprehension visual tasks. However, the issue is left unsettled since a more effective manipulation of the ITU conditions, using higher values of temporal uncertainty, might have revealed the ITU effect for the control group as compared to the schizophrenic patients. The absence of any effect of

the difference between the preceding preparatory interval minus the present preparatory interval for any of the three diagnostic groups points to the absence of minor set interference for any of the groups.

TAP-CLICK TIMING EXPERIMENT

Method

Subjects

The same subjects tested in the perceptual experiment were employed in the present tap-click timing experiment. The present experiment was given first and took about 10 min per subject.

Design

Subjects were required to tap a key in time with three regular series of clicks. Clicks were presented in three trial blocks in ascending order at the three respective interclick intervals of 1, 2 and 3 sec. Thus one of the independent variables was the interclick interval, a within-subjects manipulation. The second within-subjects variable was the test trial on which the subject responded within each interclick interval trial block. The between-subjects variable was diagnostic group, i.e. schizophrenics, psychiatric controls, and students with 32 subjects in each group. The two dependent variable measures employed were the extent

and discrepancy of the subjects tap onset relative to the click onset and a measure of the intertrial variability within each subject for the first measure.

Apparatus

Clicks were generated by a Guardian Series 200 relay encased in a metal sound box near the key the subject tapped. The timing of the series of clicks was controlled by a Hunter Model 1245 Interval timer. Settings on the timer were calibrated such that the timer generated the exact interclick intervals reported in this study. Each click had a duration of 60 msec and a sound level of 68 db. as measured from the position of the subject. The subject tapped a finger-size key which was fixed to the table 43 cm from the table edge. The key was actually a relay with a key lever attached to it. The black plastic section of the key which the subject tapped was egg-shaped with dimensions of 19 mm wide by 39 mm long. Taps and clicks were automatically recorded on a Brush Recorder Mark II at a paper speed of 25 mm/sec.

Procedure

This task was patterned after that of King (1962). All subjects were given a standard set of instructions (see Appendix C). The subject was told that this was a study of perception and that each task would be fully described to him. A series of clicks at a .5 sec interclick interval was demonstrated to the subject. He was told that

during the task he would hear a series of regular clicks and that his task was to tap the key so that his taps coincided as closely as possible with the clicks. The experimenter demonstrated with a .5 sec interclick interval. The subject was told to listen to the beat as long as he wished and then once he had the feel of the tempo to begin to tap in time with the clicks until he was asked to stop. He was told to try to synchronize his taps with the clicks. The subject then practiced tapping at .5 sec interclick intervals. Then three series of 16 clicks each were given to the subject in ascending order. Each series was at a fixed interclick interval value. The three series given were 1 sec, 2 sec, and 3 sec interclick intervals in that order. At the beginning of each series the subject was told that in this new series the clicks would beat at a somewhat slower tempo. He was told that he was doing fine at the beginning of each of the series of clicks.

Results

The dependent measure was the positively and negatively signed error score which was measured by calculating the difference between the onset time of the click and the onset time of the subject's tap for each of the test trials. Differences were measured to the nearest hundredth of a second for each trial. Within each interclick interval condition the first three trials (taps and clicks) were

considered to be practice trials and were not scored. The next ten trials were scored as the test trials. An additional three trials were given after the ten test trials in order to hold the number of trials constant for each subject while allowing for the few mistrials which sometimes occurred in which either the subject failed to respond or the pen skipped. Thus, for each of the three successive and ascending interclick interval trial blocks the deviation scores for the ten test trials were tabulated. Deviations were scored in a negative direction when the subject's tap preceded the click and in a positive direction when it followed the click. A 3 (Subject Group) x 3 (Interclick Interval) x 10 (Trials) analysis of variance was carried out for the deviation scores for each trial (see Appendix G). All factors were varied within subjects except for the subject-group factor. There were 32 subjects in each of the subject groups. The analysis revealed a statistically significant main effect for subject group, $F\ (2, 93) = 10.40,\ p < .001$. There was a statistically significant subject group x interclick interval interaction, $F\ (2, 93) = 4.65,\ p < .05$ conservative test. The trials main effect was not statistically significant using the conservative test (Geisser and Greenhouse, 1958), $F\ (1, 93) = 2.52,\ p = .25$ conservative test. However, this effect was statistically significant using the full number of degrees of freedom, $F\ (9, 837) = 2.52,\ p < .001$. The interclick interval x trials interaction was not

statistically significant using the conservative test, F (1, 93) = 1.66, p = .25 conservative test. However, this effect was statistically significant using the full number of degrees of freedom, F (18, 1674) = 1.66, $p < .05$. None of the remaining main effects or interactions were statistically significant for either the conservative or nonconservative tests. The marginal trials main effect indicates a tendency for the deviation scores to oscillate phasically and slightly increase going from earlier to later trials. The marginal trials x interclick interval interaction indicates that this tendency is more marked the longer the interclick interval with only a phasic component and no overall increase under the 2 sec interclick interval condition. Newman-Keuls tests were carried out for the differences between the three subject groups at each of the interclick interval conditions. None of the differences between the groups were statistically significant for the 1 sec interclick interval condition. For both the 2 sec and 3 sec interclick interval conditions the schizophrenics had significantly more positive deviation scores than did either the psychiatric controls or the students ($p < .01$). The psychiatric controls did not significantly differ from the students for either the 2 sec or 3 sec interclick interval conditions. For the above Newman-Keuls tests the subject group main effect and interclick interval by subjects within groups error terms were pooled and the

conservative number of degrees of freedom, df = 93, was used for the tests. Newman-Keuls tests were also carried out for the effect of interclick interval for each of the three subject groups using the interclick interval by subjects within groups error term. Statistically significant differences between interclick interval conditions emerged only for the schizophrenic group. Scores were significantly more positive ($p < .01$) for the 3 sec interclick interval condition as compared to the 2 sec and 1 sec conditions within the schizophrenic group only. These findings are plotted in Figure 5. The means and standard deviations for the tap-click signed error deviation scores are given in Appendix H.

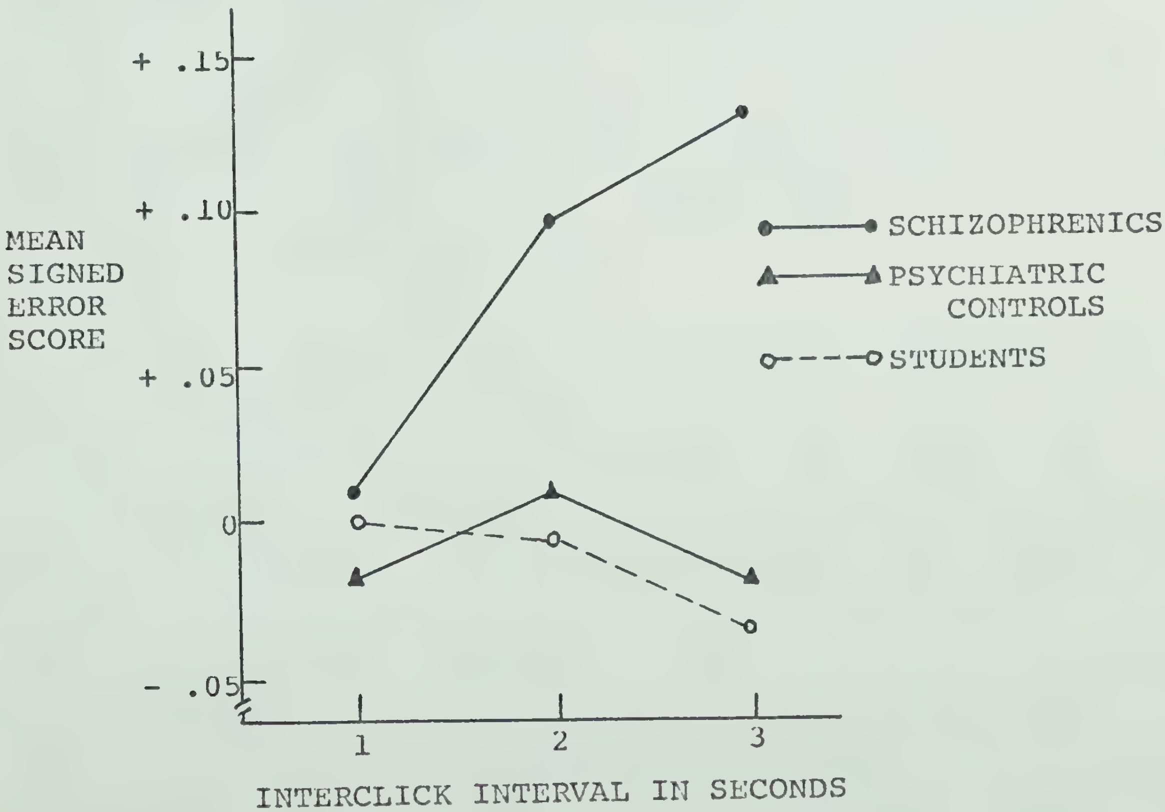

Figure 5. Mean signed error score as a function of interclick interval for the three subject groups.

The overall result of the analysis reported thus far is that schizophrenics show a response pattern in the direction of tapping after each click whereas the two nonschizophrenic groups show a response pattern in the direction of tapping slightly before each click. This effect is most marked when the interclick interval is long, 3 sec, and is not statistically significant when the interclick interval is very short, 1 sec. The schizophrenics showed a consistently more positive mean signed deviation error score as compared to the two nonschizophrenic groups for each of the ten test trials within the 2 sec and 3 sec interclick interval conditions. Furthermore, the positive error score for the schizophrenic group is far larger than the negative error scores for the two nonschizophrenic groups at the 3 sec interclick interval condition and the small negative and positive error scores for the student and psychiatric control group, respectively, at the 2 sec interclick interval condition.

Variable error scores were measured by computing the standard deviation over the ten test trials within each subject for each of the three interclick interval conditions. Using these standard deviations as the dependent measure a 3 (Subject Group) x 3 (Interclick Interval) analysis of variance was carried out (see Appendix I). The subject group factor was between subjects and the interclick interval factor was within subjects. This

analysis yielded a statistically significant main effect due to the interclick interval, $\underline{F}$ (1, 93) = 95.16, $\underline{p} < .001$ conservative test. The subject group main effect was not statistically significant. The subject group x interclick interval interaction was not statistically significant using either the conservative or nonconservative tests. Newman-Keuls tests were performed for the interclick interval main effect using the interclick interval x subjects within groups error term and the conservative number of degrees of freedom, $\underline{df}$ = 93. All of the differences for the three means were statistically significant ($\underline{p} < .01$). These means are plotted in Figure 6. The data indicate a significant increase in the variable error score for each increase in the length of the interclick interval. The means and standard deviations for the tap-click variable error scores are presented in Appendix J.

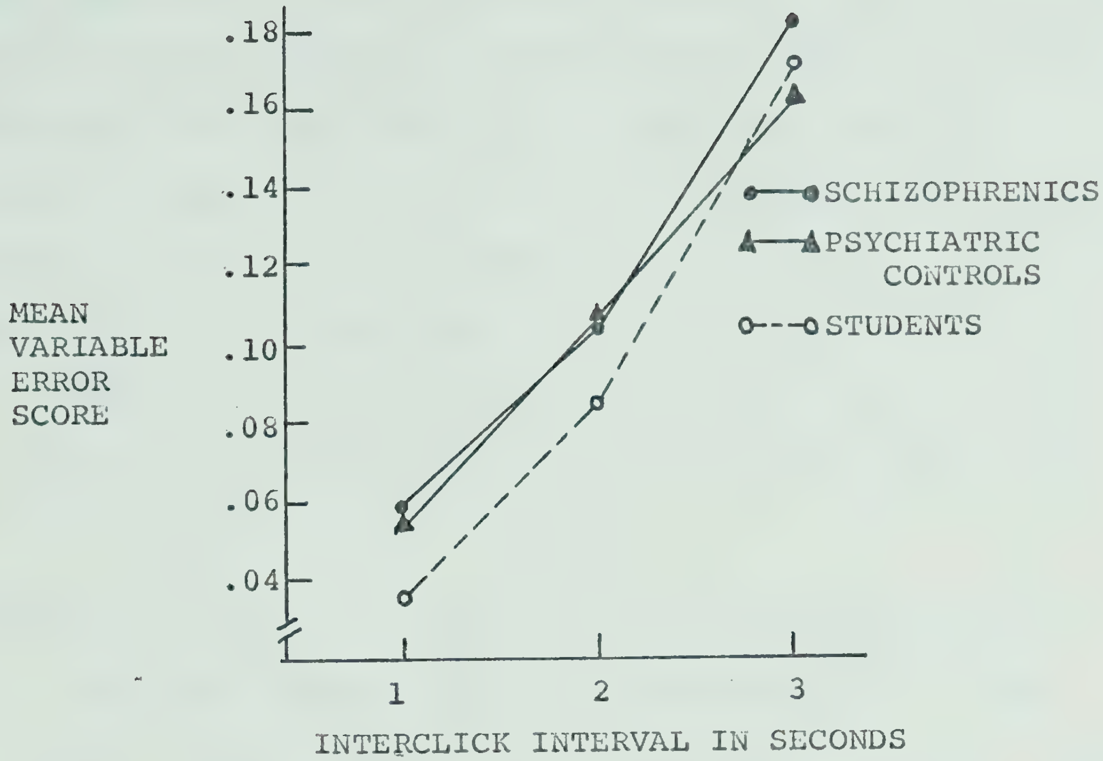

Figure 6. Mean variable error score as a function of interclick interval for the three subject groups.

It is clear from all of the findings described that there is a constant response error in the direction of schizophrenics following the click with the tap response and the nonschizophrenic groups slightly preceding each click with an anticipatory tapping response. However, there is no difference between the three groups with regard to the between-trial variability of response deviation scores within each of the interclick interval conditions.

Pearson product moment correlations were calculated

for the correlations of age and education with error scores on the tap-click timing task for each interclick interval condition within each of the three subject groups. The error scores used were variable error, mean signed error deviation scores (constant error), and the absolute value of the constant error scores. These correlations are presented in Appendix K. None of the correlations were statistically significant. They were low and near zero on the average.

<u>Summary of Results for the Tap-Click Timing Experiment</u>.

The main finding was that schizophrenics evidence a strong response bias in the direction of following regular clicks with a response whereas the psychiatric controls respond in an anticipatory way by tapping slightly before each click. This anticipatory responding on the part of the nonschizophrenic subjects allows them to respond closer in time with the clicks, i.e. the anticipatory error of the nonschizophrenic subjects is far smaller than is the post-click response error of the schizophrenic subjects. These differences are more marked with larger interclick intervals. By contrast the three groups do not differ on variable error scores, i.e. all three groups show the same level of temporal variability around their respective constant error biases. However, variable error dramatically increases with larger interclick intervals for all three groups. These findings give

evidence for a deficit in the maintenance of sensory-motor set in schizophrenics as compared to controls. Schizophrenics do not show the optimal anticipatory pattern of responding found in psychiatric controls and students.

Intercorrelations Between the Perceptual Tasks and the Tap-Click Timing Error Scores

Pearson product moment correlation coefficients were calculated for the correlations of selective attention and span of apprehension scores with the three error scores for the tap-click timing task for each interclick interval condition within each subject group (see Appendix L). The only significant correlations were negative correlations between the magnitude of variable error scores, at 1 sec interclick intervals, and span of apprehension performance scores for the schizophrenic group (r (30) = - .43, $p < .01$ one-tailed) and for the psychiatric controls (r (30) = - .30, $p < .05$ one-tailed). Students evidenced a significant negative correlation between the magnitude of variable error scores, at 2 sec interclick intervals, and selective attention scores, r (30) = - .30, $p < .05$ one-tailed. The negative correlations reported indicate some tendency for the subjects who received lower variable error on the tap-click task to evidence higher performance on the perceptual tasks and contrariwise. For the students there was a low but statistically significant negative correlation between constant error

scores and performance on the selective attention task, r (30) = - .32, $p < .05$. The reversal of the sign of this correlation when the absolute value of the constant error score was used instead, indicates that students who tapped in a more extremely anticipatory way (prestimulus responding) tended to have higher performance scores on the selective attention task. In general the results of these intercorrelations show virtually no relationship between sensory-motor timing performance and perceptual performance on selective attention and span of apprehension tasks. On those interclick interval conditions (2 sec and 3 sec) which showed the greatest differences between the schizophrenics and psychiatric controls, in terms of means, very low insignificant correlations were found between perceptual performance score variables and constant tap-click error scores. This is understandable in view of the relatively low intersubject variability on constant and variable error scores within each subject group when contrasted with the large differences in the constant error score means between the schizophrenics as compared to the nonschizophrenic groups.

CHAPTER IV

DISCUSSION

The results of the perceptual experiment of the main study do not support the hypothesis of an attention specific deficit in schizophrenic patients for selective visual recognition with distraction. Schizophrenics showed the same amount of decrement in the efficiency of performance (as measured by the proportion of correct responses), when compared to psychiatric controls and students, on the span of apprehension task, using the same type of stimulus materials, as they did on the selective attention task. For both perceptual tasks, the psychiatric controls evidenced a level of perceptual efficiency midway between the student subjects and the schizophrenic patients. Of course the student group constitutes a very atypical unrepresentative sample of nonpsychiatric subjects and differs from the psychiatric control group on many dimensions. Thus, it cannot be asserted that the psychiatric control subjects have a lower than average level of perceptual efficiency. All three groups showed the same increase in performance on the selective attention task when compared to the span of apprehension task. This finding is in keeping with the theoretical formulations of this paper regarding the

selective attentional nature of the target-letter recognition task. The results of the perceptual experiment indicated no effect on selective attention or span of apprehension of the manipulation of the temporal predictability of the stimulus display onset as measured by the interval of temporal uncertainty for any of the three subject groups (schizophrenics, psychiatric controls and students). This result is not consistent with the somewhat marginal evidence for an empirical relationship between ITU and performance on the selective attention task which was found on student subjects in pilot experiment 1. The lack of evidence for any effect of stimulus display predictability, for all three groups, makes it impossible to draw any conclusions about the nature or presence of a schizophrenic-specific deficit in the synchronization of selective perceptual sets with the time of occurance of information. However, the absence of an attention-specific deficit for the schizophrenic group in terms of performance scores suggests that the lower performance of schizophrenics on the selective attention task is not due to a primary impairment of the ability to form, maintain or interface selective encoding operations as compared to non-selective encoding operations. The absence of a differential effect of the self-initiate condition for both the selective attention task and the span of apprehension task provides no evidence for the hypothesis of Shakow (1962)

that schizophrenics perform worse when given control over a task whereas controls perform better. Analyses of the effects of the length of preparatory interval as well as preceding preparatory interval minus preparatory interval differences yielded no theoretically relevant results in terms of the emphasis of the paper. In general, all manipulations and analyses having to do with the temporal parameters of stimulus display onset led to the conclusion that these temporal parameters had no effect on perceptual performance for any group in the main study. The manipulation of the temporal predictability of the stimulus array might have been more effective if a longer preparatory interval midpoint as well as longer intervals of temporal uncertainty had been employed. Selective perceptual sets may be voluntarily and continuously maintained by subjects for a sufficient length of time such that very wide ranges of temporal uncertainty are necessary in order to "desynchronize" their coincidence with the stimulus events. The present findings do not support the theories of Shakow (1962, 1963), McGhie (1966) and Cromwell and Dokecki (1968) in terms of a specific impairment in the ability to selectively process visual input in schizophrenia. The small load on active verbal memory placed by the selective attention task and the fact that the performance decrement on this task was equal to the performance decrement on the span of apprehension task when schizophrenics are compared to controls,

suggests that the nonspecific perceptual deficit found in the main study was not due to a possibly defective active verbal memory in schizophrenia. If schizophrenics had a lower capacity for storage into or retrieved from active verbal memory than did controls, then the greater memory load placed by the span task should have produced more of a drop in span scores relative to selective attention scores for the schizophrenic group as compared to the controls.

The results of the perceptual experiment support the conclusions of Davidson and Neale (1974) that although the target-letter detection task (selective attention task) employed here does involve the selective processing of input, differences between the scores on this task for schizophrenic patients as compared to controls are not a function of the selective attentional aspect of the task. In agreement with the hypotheses of Davidson and Neale (1974) and a recent study by Saccuzzo, Hirt, and Spencer (1974) the present findings are consistent with the hypothesis of an information processing deficit in schizophrenia either at an early preattentive level of perceptual organization, in terms of inefficient preattentive processing of information or an alteration of iconic memory parameters; or a general slowness in the selective as well as nonselective extraction of information from the icon. The notion of a slower processing

of information from sensory memory in schizophrenia was put forwards by Yates (1966) and still remains as a simple and plausible explanation of impaired perceptual functioning in schizophrenia. Saccuzzo, Hirt, and Spencer (1974) compared chronic schizophrenic patients to psychiatric controls and students in an experiment which utilized a backward masking procedure with a high energy pattern mask to measure the rate of delay of information in iconic memory. The task employed was a variant of the target-letter recognition task (selective attention task) used in the main study of this paper. For both the recognition of target letters with and without distractor letters, the results showed that the control groups had processed all of the information at a post-stimulus offset delay of 200 msec. Both paranoid and nonparanoid schizophrenics were still processing information from the icon at the longest delay measured, 300 msec. These results indicated that the icon in schizophrenia lasts longer than the length of iconic memory which is utilized by controls. Clearly these results are contrary to the hypothesis of a shorter iconic memory in schizophrenia. Possibilities considered by the authors on the basis of their study for schizophrenic subjects included: a degraded quality of iconic storage, a slower processing of information from the icon, or an abnormally long icon which actually consists of the emergence of a second

duplicate icon which masks information in the first icon. Despite all of the possibilities discussed above it is also conceivable that the results of the present study are indicative of a general performance deficit in schizophrenia.

The results of the tap-click timing experiment gave clear evidence for an impairment of the ability to synchronize motor responses with temporally predictable and regular sequences of stimuli in schizophrenic patients. The difference was in the direction of schizophrenics having relatively large and positive constant error scores and both control groups having in general relatively small and negative constant error scores. Schizophrenics responded in the direction of tapping after each click by a relatively long latency whereas the controls responded in the direction of tapping slightly before each click thereby approaching synchronization of responses with stimuli. The schizophrenics showed a larger post-stimulus constant error for successively longer interclick intervals whereas the controls showed no significant change in their generally pre-stimulus constant error for successively longer interclick intervals. These results point to the relatively successful attempt on the part of psychiatric controls and students to anticipate or project the time of occurrence of the sensory events and to respond in accordance with these

temporal projections and thereby synchronize the sensory and motor events. On the other hand, the schizophrenics are less successful in this attempt if it is made at all. The post-stimulus constant error of the schizophrenic group could result from less of an ability to succeed in the attempt to synchronize responses with stimuli. Another possibility is that the schizophrenics did not attempt the synchronization and instead treated the task as a reaction-time task. The size of the mean constant error scores (less than 150 msec) for schizophrenics in the present study was far below the simple auditory RTs of schizophrenics for regular preparatory intervals of three seconds (mean RT was over 300 msec), and below the mean RT for normal controls at regular preparatory intervals of three seconds (mean RT was approximately 175 msec) as reported by Huston, Shakow, and Riggs (1937). This comparison would argue against the hypothesis that, in the present study, schizophrenics did not attempt a sensory-motor synchronization set. Less than one third of the schizophrenics showed uniformly post-stimulus responses for all trials under the two second interclick interval condition and less than half under the three second condition. These are the two conditions on which schizophrenics significantly differ from controls.

The finding that all three groups show the same increase in variability of responses around their constant error means with longer interclick intervals and the finding that the three groups do not differ on variable error at any of the interclick interval condition points to the absence of a difference between schizophrenics and controls in the regularity of response behavior. The three groups have responses which are equally time-locked to the stimulus. The group differences lie in the extent to which this relatively time-locked behavior is in synchrony with the stimuli as well as the directionality of the extent of lack of synchrony. The statistical analysis revealed no differences between the groups in the change of constant error across stimulus trials within each interclick interval condition. There was only a marginally more positive constant error shift with successive trials which was equal for all three groups. Thus, there is no evidence for schizophrenics to show an effect of a successively longer post-stimulus latency of response when compared to controls. There was little evidence for such an effect in any of the subject groups.

There are a number of possible explanations for the inability of schizophrenics to successfully synchronize motor responses with regular series of stimulus

events. King (1962), whose study the present experiment was patterned after, speculated that the synchronization impairment is due to the general slowness of psychomotor responsiveness in schizophrenic patients (see also the reaction time studies reviewed in Chapter I). A slower response rate would lead to progressively more positive (post-stimulus) and larger constant error scores moving from early to late trials on the type of task used here. Extremely slow response rates would require a reset of response location in time after a given number of trials in order for the subject to elicit one response per stimulus. The results of this study show that the marginal trial effect found, was equal for all three groups. Hence, the hypothesis that a synchronization impairment in schizophrenia is due to psychomotor retardation is not supported by the present study. King (1962) failed to perform the trial analysis that would have allowed him to test his retardation hypothesis. Another possibility is that a competatory response inhibition builds up as the schizophrenic progressively intensifies over the interstimulus interval his voluntary response elicitation readiness. This response inhibition could interfere with the voluntary performance of the response at a correctly anticipated time of stimulus occurrence. If the inhibition dissipated after each response was performed, a slower

rate of responding would not result. A response inhibition explanation of the sensory-motor synchronization impairment in schizophrenia for reaction time tasks at regular preparatory intervals was proposed by Steffy and Galbraith (1974). They have suggested that protective inhibition may be greater when schizophrenics can predict the time of stimulus onset than when they cannot. Protective inhibition could lead not only to an inhibition of central responsiveness to a stimulus, but also to the inhibition of anticipatory readiness for an overt response since response readiness may itself be excitatory. A sensory-motor synchronization impairment might also be due to an inability to maintain a major set (in this case an accurate temporal sensory-motor set) in schizophrenia as proposed by Shakow (1962, 1963). Shakow hypothesized that the steeper increase in reaction time, as regular preparatory intervals got longer, for schizophrenics as compared to controls was due to the greater intrusion of irrelevant minor sets for schizophrenics over the duration of the longer preparatory intervals. In the present tap-click timing experiment, a greater post-stimulus constant error score with longer intertrial intervals was found for schizophrenics but not for the controls. Minor-set intrusion for schizophrenics might be more pronounced for the longer intertrial intervals resulting in a poorer main-

tenance of the major synchronization set at these longer intertrial intervals and hence a longer post-stimulus constant error score for longer intertrial intervals.

Examination of the correlations between scores on the tap-click timing task with selective attention and span of apprehension scores showed, in general, no predictive relationship between sensory-motor timing behavior and perceptual performance. There was no evidence for the notion that a dimension of the ability to maintain a major set underlies individual differences in both the selective recognition of visual targets and the synchronization of motor responses to predicable regular series of auditory stimuli. The significant negative correlation between span of apprehension performance and variable error scores for one second interclick intervals on the tap-click timing task, for both schizophrenic and nonschizophrenic psychiatric patients, may reflect a perceptual motor retardation factor which influences these two measures.

The results of the main study have not contributed as much to a better understanding of perceptual functioning in schizophrenia as the author would have liked. The finding of the absence of an attention-specific deficit for schizophrenic patients in the area of visual

recognition is in keeping with recent research findings by authors such as Saccuzzo, Hirt, and Spencer (1974) and Davidson and Neale (1974). These recent findings, in agreement with the present study, point to the primacy in schizophrenia of a perceptual-cognitive impairment which underlies deficits in both selective and non-selective visual information processing. The future investigation of pre-attentive processes and storage, as well as factors influencing the rate or efficiency of the visual encoding process, will hopefully lead to a more complete scientific understanding of the alteration of perceptual and cognitive functioning and experience in schizophrenic and nonschizophrenic psychiatric patients, especially when experimental perceptual research and theorizing is integrated with neurophysiological research on central nervous system correlates of psychological functioning in psychiatric patients.

REFERENCES

Averbach, E., & Coriell, A.S. Short-term memory in vision. Bell System Technical Journal, 1961, 40, 309-328.

Bannister, D. The logical requirements of research into schizophrenia. British Journal of Psychiatry, 1968, 114, 181-188.

Bauman, E., & Murray, D.J. Recognition versus recall in schizophrenia. Canadian Journal of Psychology, 1968, 22, 18-25.

Bellissimo, A., & Steffy, R.A. Redundancy-associated deficit in schizophrenic reaction time performance. Journal of Abnormal Psychology, 1972, 80, 299-307.

Bemporad, J.R. Perceptual disorders in schizophrenia. American Journal of Psychiatry, 1967, 123, 971-976.

Bleuler, E.P. Dementia praecox or the group of schizophrenias. J. Zinkin (Trans.), New York: International Universities Press, 1950.

Blewett, D.B., & Weckowicz, T.E. Size constancy and abstact thinking in schizophrenic patients: A factor analytic study. Schozophrenia, 1970, 2, 123-127.

Broadbent, D.E. Perception and communication. New York: Pergamon Press, 1958.

Bryant, A.R.P. An investigation of process-reactive schizophrenia with relation to perception of visual space. Unpublished doctoral dissertation, University of Utah, 1961.

Buss, A.H., & Lang, P.J. Psychological deficit in schizophrenia I: Affect, reinforcement and concept attainment. Journal of Abnormal Psychology, 1965, 70, 2-24.

Callaway, E., & Thompson, S.V. Sympathetic activity and perception. Phychosomatic Medicine, 1953, 15, 443-455.

Cash, T.F., Neale, J.M., & Cromwell, R.L. Span of apprehension in acute schizophrenics: Full-report technique. Journal of Abnormal Psychology, 1972, 79, 322-326.

Chapman, J. The early symptoms of schizophrenia. British Journal of Psychiatry, 1966, 112, 225-251.

Chapman, J.S., & McGhie, A.A. A comparative study of disordered attention in schizophrenia. Journal of Mental Science, 1962, 108, 487-500.

Cromwell, R.L., & Dokecki, P.R. Schizophrenic language: A disatention interpretation. In S. Rosenberg & J.H. Koplin (Eds.), Developments in Applied Psycholinguistics Research. New York: Macmillion, 1968, pp. 209-260.

Davidson, G.S., & Neale, J.M. The effects of signal-noise similarity on visual information processing of schizophrenics. Journal of Abnormal Psychology, 1974, 83, 683-686.

Davis, D., Cromwell, R.L. & Held, J.M. Size estimation in emotionally disturbed children and schoizophrenic adults. Journal of Abnormal Psychology, 1967, 72, 395-401.

Duetsch, J.A., & Deutsch, D. Attention: Some theoretical considerations. Psychological Review, 1963, 70, 80-90.

Draguns, J.G. Responses to cognitive and perceptual ambiguity in chronic and acute schizophrenics. Journal of Abnormal and Social Phychology, 1963, 66, 24-30.

Easterbrook, J.A. The effect of emotion on cue utilization and the organization of behavior. Psychological Review, 1959, 66, 183-201.

Egan, J.P., Greenberg, G.Z., & Schulman, A.I. Interval of time uncertainty in auditory detection. In J.A. Swets (Ed.), Signal detection and recognition by human observers: Contemporary readings. New York: Wiley, 1964.

Eriksen, C.W., & Johnson, H.J. Storage and decay characteristics of non-attended auditory stimuli. Journal of Experimental Psychology, 1964, 68, 28-36.

Estes, W.K. A technique for assessing variability of perceptual span. Proceedings of the National Academy of Sciences, 1965, 54, 403-407.

Estes, W.K., & Taylor, H.A. A detection method and probabilistic models for assessing information processing from brief visual displays. Proceedings of the National Academy of Sciences, 1964, 52, 446-454.

Estes, W.K., & Taylor, H.A. Visual detection in relation to display size and redundancy of critical elements. Perception and Psychophysics, 1966, 1, 9-16.

Freedman, B., & Chapman, L.J. Early subjective experience schizophrenic episodes. Journal of Abnormal Psychology, 1973, 82, 46-54.

Gardner, R.W. Cognitive controls of attention deployment as determinants of visual illusions. Journal of Abnormal and Social Psychology, 1961, 62, 120-127.

Geisser, S., & Greenhouse, W.W. An extension of Box's results on the use of the F distribution in multivariate analysis. Annals of Mathematical Statistics, 1958, 29, 885-891.

Granville-Grossman, K. Recent advances in clinical psychiatry. London: J.& A. Churchill, 1971.

Green, D.M., & Swets, J.A. Signal detection theory and psychophysics. New York: Wiley, 1966.

Hamilton, V. Size constancy and cue responsiveness in psychosis. British Journal of Psychology, 1963, 54, 25-39.

Harris, J.G. Size estimation of pictures as a function of thematic content for schizophrenic and normal subjects. Journal of Personality, 1957, 25, 651-671.

Harway, N.I., & Salzman, L.F. Size constancy in psychopathology, Journal of Abnormal and Social Psychology, 1964, 69, 606-613.

Held, J.M. & Cromwell, R.L. Premorbid adjustment in schizophrenia. Journal of Nervous and Mental Disease, 1968, 146, 264-272.

Hochberg, J. Attention, organization and consciousness. In D.I. Mostofsky (Ed.), Attention: Contemporary theory and analysis. New York: Appleton-Century-Crofts, 1970.

Hollister, L.E. Choice of antipsychotic crugs. American Journal of Psychiatry, 1970, 127, 186-190.

Huston, P.E., Shakow, D., & Riggs, L.A. Studies of motor function in schizophrenia. II Reaction Time. Journal of General Psychology, 1937, 16, 39-82.

Huston, P.E., & Singer, M.M. Effect of sodium amytal and amphetamine sulphate on mental set in schizophrenia. Archives of Neurology and Psychiatry, 1945, 53, 365-369.

Jung, C.G. The psychology of dementia praecox. In H. Read, M. Fordham, & G. Adler (Eds.), The collected works of C.G. Jung: Vol. 3, The psychologenesis of mental disease. New York: Pantheon Books, 1960.

Kahneman, D. Attention and effort. New Jersey: Prentice-Hall, 1973.

Kar, B.C. Muller-Lyer illusion in schizophrenics as a function of field distraction and exposure time. Unpublished master's thesis, George Peabody College for Teachers, 1967.

King, H.E. Anticipatory behavior: Temporal matching by normal and psychotic subjects. Journal of Psychology, 1962, 53, 425-440.

Korboot, P., & Yates, A.J. Speed of perceptual functioning in chronic nonparaniod schizophrenics: Partical replication and extension. Journal of Abnormal Psychology, 1973, 81, 296-298.

Lang, P.J., & Buss, A.H. Psychological deficit in schizophrenia II: Interference and activation. Journal of Abnormal Psychology, 1965, 70, 77-106.

Lawson, J.S., McGhie, A. & Chapman, J. Distractibility in schizophrenia and organic cerebral disease. British Journal of Psychiatry, 1967, 113, 527-535.

Leibowitz, H.W., & Pishkin, V. Perceptual size constancy in chronic schizophrenia. Journal of Consulting Psychology, 1961, 25, 196-199.

Lhamon, W.T., & Goldstone, S. The time sense: Estimation of one second durations by schizophrenic patients. Archives of Neurology and Psychiatry, 1956, 76, 625-629.

Lovinger, E. Perceptual contact with reality in schizophrenia. Journal of Abnormal and Social Psychology, 1956, 52, 87-91.

Ludwig, A.M., Stilson, D.W., Wood, B.S., & Downs, M.P. Further studies on audition in schizophrenia. American Journal of Psychiatry, 1963, 120, 70-71.

Ludwig, A.M., Wood, B.S., Jr., & Downs, M.P. Auditory studies in schizophrenia. American Journal of Psychiatry, 1962, 119, 122-127.

Mackworth, J.F. The relation between the visual image and post-perceptual immediate memory. Journal of Verbal Learning and Verbal Behavior, 1963, 2, 75-85.

Magaro, P.A., & Vojtisek, J.E. Embedded figures performance of schizophrenics as a function of chronicity, premorbid adjustment, diagnosis and medication. Journal of Abnormal Psychology, 1971, 72, 184-191.

McGhie, A. Psychological studies of schizophrenia. British Journal of Medical Psychology, 1966, 39, 281-288.

McGhie, A. Attention and perception in schizophrenia. In R. Cancro (Ed.), Annual review of the schizophrenic syndrome. New York: Brunner & Mazel, 1972.

McGhie, A., & Chapman, J.S. Disorders of attention and perception in early schizophrenia. British Journal of Medical Psychology, 1961, 34, 103-117.

McGhie, A., Chapman, J., & Lawson, J.S. Effect of distraction on schizophrenic performance. (1) Perception and immediate memory. (2) Psychomotor ability. British Journal of Psychiatry, 1965, 111, 363-398.

McIntyre, C.W., Fox, R., & Neale, J.M. Effects of noise similarity and redundancy on the information processed from brief visual displays. Perception and Psychophsics, 1970, 7, 328-332.

McKinnon, T., & Singer, G. Schizophrenia and the scanning cognitive control: A re-evaluation. Journal of Abnormal Psychology, 1969, 74, 242-249.

Mellor, C.S. First rank symptoms of schizophrenia. British Journal of Psychiatry, 1970, 117, 15-23.

Moray, N. Attention in dichotic listening: Affective cues and the influence of instructions. Quarterly Journal of Experimental Psychology, 1959, 11, 56-60.

Neale, J.M. Perceptual span in schizophrenia. Journal of Abnormal Psychology, 1971, 77, 196-204.

Neale, J.M. & Cromwell, R.L. Size estimation in schizophrenics as a function of stimulus presentation time. Journal of Abnormal Psychology, 1968, 73, 44-49.

Neale, J.M., & Cromwell, R.L. Attention and schizophrenia. In B.A. Maher (Ed.), Progress in experimental personality research. Vol. 5. New York: Academic Press, 1970.

Neale, J.M., McIntyre, C.W., Fox, R., & Cromwell, R.L. Span of apprehension in acute schizophrenics. Journal of Abnormal Psychology, 1969, 74, 593-596.

Neisser, U. Decision-time without reaction-time: Experiments in visual scanning. American Journal of Psychology, 1963, 76, 376-385.

Neisser, U. Cognitive psychology. New York: Meredith, 1967.

Neisser, U., Novick, R., & Lazar, R. Searching for ten targets simultaneously. Perceptual and Motor Skills, 1963, 17, 955-961.

Neisser, U., & Stoper, A. Redirecting the search process. British Journal of Psychology, 1965, 56, 359-368.

Nideffer, R.M., Neale, J.M., Kopfstein, J.H., & Cromwell, R.L. The effect of previous preparatory intervals upon anticipatory responses in the reaction time of schizophrenic and nonschizophrenic patients. The Journal of Nervous and Mental Disease, 1971, 153, 360-365.

Norman, D.A. Toward a theory of memory and attention. Psychological Review, 1968, 75, 522-536.

Pavlov, I.P. Conditioned reflexes and psychiatry. W.H. Grant (Trans.), New York: International Press, 1941.

Payne, R.W., Hochberg, A.C., & Hawks, D.V. Dichotic stimulation as a method of assessing disorder of attention in overinclusive schizophrenic patients. Journal of Abnormal Psychology, 1970, 76, 135-193.

Piaget, J. The psychology of intelligence. London: Routledge & Kegan Paul, 1950.

Pollack, I. Message uncertainty and message reception. Journal of the Acoustical Society of America, 1959, 31, 1500-1508.

Price, R.H., & Erikson, C.W. Size constancy in schizophrenia: A reanalysis. Journal of Abnormal Psychology, 1966, 71, 155-161.

Rappaport, M. Ability of acute schizophrenics to attend to competing voice messages: Effects of message load and drugs. Archives of General Psychiatry, 1967, 17, 97-103.

Rappaport, M. Attention to competing voice messages by non-acute schizophrenic patients: Effects of message load, drugs, dosage levels and patient background. Journal of Nervous and Mental Disease, 1968, 146, 404-411.

Rappaport, M., Rogers, N., Reynolds, S., & Weinmann, R. Comparative ability of normal and chronic schizophrenic subjects to attend to competing voice messages: Effects of method of presentation, message load and drugs. Journal of Nervous and Mental Disease, 1966, 143, 16-27.

Raush, H.L. Perceptual constancy in schizophrenia. Journal of Personality, 1952, 21, 176-187.

Rodnick, E.H., & Shadow, D. Set in the schizophrenic as measured by a composite reaction time index. American Journal of Psychiatry, 1940, 97, 214-225.

Rosenthal, D., Lawlor, W.G., Zahn, T.P., & Shakow, D. The relationship of some aspects of mental set to degree of schizophrenic disorganization. Journal of Personality, 1960, 28, 26-38.

Saccuzzo, D.P., Hirt, M., & Spencer, T. Backward masking as a measure of attention in schizophrenia. Journal of Abnormal Psychology, 1974, 83, 512-522.

Schneider, K. Klinische psychopathologie, English translation Clinical psychopathology, (5th Edition). New York: Grune & Stratton, 1959.

Shakow, D. Segmental set: A theory of formal psychological deficit in schizophrenia. Archives of General Psychiatry, 1962, 6, 1-17.

Shakow, D. Psychological deficit in schizophrenia. Behavioral Science, 1963, 8, 275-305.

Silverman, J. The problem of attention in research and theory on schizophrenia. Psychological Review, 1964, 71, 352-379. (a)

Silverman, J. Scanning-control mechanism and "cognitive filtering" in paranoid and non-paranoid schizophrenia. Journal of Consulting Psychology, 1964, 28, 385-393. (b)

Silverman, J., & Gaader, K. Rates of saccadic eye movement and size judgements of normals and schizophrenics. Perceptual and Motor Skills, 1967, 25, 661-667.

Sperling, G. The information available in brief visual presentations. Psychological Monographs, 1960, 74, (11, Whole No. 498).

Spohn, H.E., Thetford, P.E., & Woodham, F.L. Span of apprehension and arousal in schizophrenia. Journal of Abnormal Psychology, 1970, 75, 113-123.

Starr, B.J., Leibowitz, H.W., & Lundy, R.M. Size constancy in catatonia. Perceptual and Motor Skills, 1968, 26, 747-752.

Steffy, R.A., & Galbraith, K. A comparison of segmental set and inhibatory deficit explorations of the crossover pattern in process schizophrenic reaction time. Journal of Abnormal Psychology, 1974, 83, 227-233.

Stilson, D.W., & Kopell, B.S. The recognition of visual signals in the presence of visual noise by psychiatric patients. Journal of Nervous and Mental Disease, 1964, 139, 209-221.

Stilson, D.W., Kopell, B.S., Vandenbergh, R., & Downs, M.P. Perceptual recognition in the presence of noise by psychiatric patients. Journal of Nervous and Mental Disease, 1966, 142, 235-247.

Sugarman, A.A., & Cancro, R. Field independence and outcome in schizophrenia: A U-shaped relationship. Perceptual and Motor Skills, 1968, 27, 1007-1013.

Taylor, J.N. A comparison of delusional and hallucinatory individuals using field dependency as a measure. Unpublished doctoral dissertation, Purdue University, 1956.

Tizard, J., & Venables, P.H. Reaction time responses by schizophrenic mental defectives and normal adults. American Journal of Psychiatry, 1956, 112, 803-807.

Treisman, A.M. Contextual cues in slective listening. Quarterly Journal of Experimental Psychology, 1960, 12, 242-248.

Treisman, A.M. Monitoring and storage of irrelevant messages in selective attention. Journal of Verbal Learning and Verbal Behavior, 1964, 3, 449-459. (a)

Treisman, A.M. Selective attention in man. British Medical Bulletin, 1964, 20, 12-16.

Ullmann, L.P., & Giovannoni, J.M. The development of a self-report measure of the process-reactive continuum. Journal of Nervous and Mental Disease, 1964, 138, 38-42.

Venables, P.H. Input dysfunction in schizophrenia. In B.A. Maher (Ed.), Progress in experimental personality research, Vol. I. New York: Academic Press, 1964.

Webster, F.R., Goldstone, S., & Webb, W.W. Time judgment and schizophrenia: Psychophysical method as a relevant contextual factor. Journal of Psychology, 1962, 54, 159-164,

Weckowicz, T.E. Size constancy in schizophrenic patients. Journal of Mental Science, 1957, 103(432), 475-486.

Weckowicz, T.E. Perception of hidden pictures by schizophrenic patients. Archives of General Psychiatry, 1960, 2, 521-527.

Weckowicz, T.E., & Blewett, D.B. Size constancy and abstract thinking in schizophrenic patients. The Journal of Mental Science, 1959, 105, 909-934.

Weckowicz, T.E., & Witney, G. The Muller-lyer illusion in schizophrenic patients. Journal of Mental Science, 1960, 106(444), 1002-1007.

Weinstein, A.D., Goldstone, S., & Boardman, W.K. The effect of recent and remote frames of reference on temporal judgments of schizophrenic patients. Journal of Abnormal Psychology, 1958, 57, 241-244.

Winer, B.J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

Wing, J.K., Birley, J.L.T., Cooper, J.E., Graham, P., & Isaacs, A.D. Reliability of a procedure for measuring and classifying "present psychiatric state." British Journal of Psychiatry, 1967, 113, 499-515.

Wishner, J. The concept of efficiency in psychological health and in psychopathology. Psychological Review, 1955, 62, 69-80.

Witkin, H.A., Lewis, H.B., Hertzman, M., Machover, K., Betnall-Meisser, P., & Wapner, S. Personality through perception. New York: Harper & Row, 1954.

Yates, A.J. Data processing levels and thought disorder in schizophrenia. Australian Journal of Psychology, 1966, 18, 103-117.

Yates, A.J., & Korboot, P. Speed of perceptual functioning in chronic nonparanoid schizophrenics. Journal of Abnormal Psychology, 1970, 76, 453-461.

Zahn, T.P. Acquired and symbolic affective value as determinants of size estimation in schizophrenic and normal subjects. Journal of Abnormal and Social Psychology, 1959, 58, 39-47.

Zahn, T.P., Rosenthal, D., & Shakow, D. Reaction time in schizophrenic and normal subjects in relation to the sequence of series of regular preparatory intervals. Journal of Abnormal and Social Psychology, 1961, 63, 161-168.

Zahn, T.P., Rosenthal, D., & Shakow, D. Effects of irregular preparatory intervals on reaction time in schizophrenia. Journal of Abnormal and Social Psychology, 1963, 67, 44-52.

Zahn, T.P., & Rosenthal, D. Preparatory set in acute schizophrenia. Journal of Nervous and Mental Disease, 1965, 141, 352-358.

Zubin, J. Classification of the behaviour disorders. Annual Review of Psychology, 1967, 18, 373-406.

APPENDIX A

SYMPTOM AND SIGN CHECK LIST
FOR SCHIZOPHRENIC PATIENTS

DESCRIPTION

This check list is designed for use with patients you have already diagnosed as schizophrenic or where you are in the process of considering a diagnosis of schizophrenia.

It is hoped that the information tabulated from these check lists will help to provide a summary clinical description of those patients diagnosed as schizophrenic who are included in the present study on selective perception in schizophrenia. Items on the check list follow the schemes of K. Schneider and E. Bleuler as outlined.

It is <u>not</u> the purpose of this check list to direct or structure your clinical judgement. It is <u>not</u> the purpose of this check list to arrive at a numerical scale for schizophrenia.

Your time and cooperation are much appreciated.

Sincerely,

Lawrence F. Spreng

All Information Requested Below Will Be Kept Completely Confidential

Patient's name ______________________________

Diagnostician ______________________________

Date patient was interviewed ____________________

Date check list completed ______________________

I. Type of schizophrenia (please check one):

______ simple ______ Paranoid

______ hebephrenic ______ Undifferentiated

______ catatonic

II. This patient manifests (please check one):

______ process schizophrenia

______ reactive schizophrenia

______ cannot decide in this case

III. I would judge this patient to be (please check one):

______ mildly disintegrated

______ moderately disintegrated

______ severely disintegrated

PART ONE

K. SCHNEIDER'S SYMPTOMS OF THE FIRST RANK

_____ 1. Hears his own thoughts spoken aloud (*écho de la pensée*) (*Gedankenlautwerdan*).

_____ 2. Hears hallucinatory voices in the form of statement and reply so that he hears voices speaking about him in the third person.

_____ 3. Hears hallucinatory voices in the form of a running commentary.

_____ 4. Has bodily hallucinatory experienced as bodily sensations which he knows are being produced by external agencies.

_____ 5. Experiences thought withdrawal, thought insertion and other influences on thought.

_____ 6. Experiences thought broadcasting.

_____ 7. Experiences delusional perception (perceptual apophany).

_____ 8. Has experiences of influence (passivity) in the spheres of feeling, drives, or volition.

PART TWO

E. BLEULER'S FUNDAMENTAL SYMPTOMS AND SIGNS

Please check the major headings you believe apply to this patient.
Please follow additional instructions under the headings you check:

Bleuler's Simple Functions -

_____ A. Disorder of Association - Formal Thought Disorder

Please give a brief description of those formal characteristics of thought (as expressed in the patient's speech) which led you to check this category, e.g. "thought not directed", "excessive blocking", "dearth of ideas", "symbolism", "neologisms", "clang associations", knight moves".

(A list of descriptions commonly associated with formal thought disorder is provided for you at the end of the inventory.

PART TWO (Con't.)

_____ B. Disorder of Affect

Please check those that apply:

_____ flattened affect

_____ incongruent affect

_____ indifference

_____ basic mood unrelated to and unaffected by external events

_____ impervious to pain and discomfort

_____ affect lags behind ideas

_____ oversensitivity but lack of depth

_____ rapid alteration of expression

_____ lack of affective adaptability

_____ C. Ambivalence

Please check those that apply:

_____ affective ambivalence

_____ ambivalence of will (ambitendency)

_____ intellectual ambivalence (counterthinking)

Bleuler's Compound Functions -

_____ D. Autism

_____ E. Disorder of Attention

Please check those that apply:

_____ active attention lacking

_____ selectivity of attention reduced or absent

_____ splitting of attention

_____ blocking of attention

PART TWO (Con't.)

_____ F. Disorder of Will - Weakness or Loss of Volition, Lack of Tenacity and Unity of Volition.

_____ G. A Splitting or Disintegration of the Self or Ego.

_____ H. Presence of Schizophrenic Dementia -

Here Bleuler refers not to the patient necessarily being generally demented. He refers also to dementia with regard to certain periods, certain constellations, and certain complexes.

_____ I. Disorders of Activity and Behaviour as outlined below.

Check those that apply:

_____ lack of interest, initiative or definite goals

_____ no capacity for variation in work

_____ changes jobs and occupations frequently

_____ irritability, stubborness, moody

_____ avoids work

_____ goals not compatible with abilities or mental predispositions

_____ incomprehensible behavior

_____ acts as though others didn't exist

PART THREE

Please give any other symptoms or signs not covered in the previous sections which you consider relevant to or decisive of your diagnosis of schizophrenia for this patient.

LIST OF DESCRIPTORS COMMONLY ASSOCIATED WITH THE CONCEPT OF FORMAL THOUGHT DISORDER

From Bleuler:

Thinking not directed (absence of central determining idea)

Loss of continuity of associations

Associations tend to proceed along new lines

Blocking

Confusion _sui genesis_

Condensation (Ideas are lumped together regardless of logic. In word condensation we might have "chable" - chair + table.)

Displacement (An associated idea is used in place of the right one.)

Symbolism (Misuse of symbols usually in a concrete way.)

Clang associations

Stereotyped associations

Censuras or sudden leaps in thinking ("knight moves")

Dearth of ideas

Pressure of thoughts

Clings to one idea

Naming

Completion of phrases that don't fit

Two ideas fortuitously encountered are combined

Thoughts linked by auxillary images

Associations formed by habit, similarity, subordinating causality

Part concepts normally never missing are ineffective

Thought connections are determined emotionally

Mediate associations.

<u>From Other Sources</u>:

<u>Cameron</u> -

Asyndetic thinking (lack of genuine causal links)

Metonyms

Interpenetration of themes

Overinclusiveness

<u>Goldstein</u> -

Concrete thinking

<u>C. Schneider</u> -

Fusion (heterogenous elements of speech are blended together in a senseless unity.)

Derailment (speech proceeds along a given path but then suddenly slips into a new direction.)

Omission (part of a thought in the main stream drops out.)

Drivelling (sequences of thought fairly well forced and organized are mixed up together in confusion.)

<u>Kleist</u> -

Incoherence

Paralogia

Alogia

Neologisms

<u>Fish</u> -

Negative formal thought disorder

Positive formal thought disorder

<u>Other Sources</u> -

Perseveration

<u>Vorbeireden</u>

Thought diffusion

APPRENDIX B

THE ULLMANN AND GIOVANNONI
SELF-REPORT SCALE OF REMORBID ADJUSTMENT

ULLMANN AND GIOVANNONI SELF-REPORT SCALE

For each of the statements presented below answer "True" if you agree with the statement, if it describes you. Answer "False" if you do not agree with the statement, if it does not describe you.

1. When I leave the hospital, I will live with my wife ________ T F
2. I am married now. ________ T F
3. I have fathered children. ________ T F
4. I have been married. ________ T F
5. Before I was seventeen I had left the home I was raised in and never went back except for visits. ________ T F
6. When I leave the hospital, I will live with one or both of my parents. ________ T F
7. As a civilian I have worked steadily at one job or for one employer for over two years. _ T F
8. I finished at least one year of education after high school - trade apprenticeship, business school, college, etc. ________ T F
9. Adding up all the money I earned for the last three years, it comes to less than $700, before deductions. ________ T F
10. In my teens I was a member of a group of friends who did things together. ________ T F
11. I hardly ever went over to another kid's house after school or on weekends. ________ T F
12. When I was in school I didn't like Physical Education classes. ________ T F
13. Alcohol has nothing to do with my difficulties. T F
14. I have paid regularly to buy a house. ________ T F
15. More than once in the last year I have stayed on after some group meeting and talked with some other members about something that went on. T F

16. Shortly before I came to the hospital there was some major change in my life - such as marriage, birth of a baby, death, injury, loss of job, etc. ______ T F

17. I have been deeply in love with someone and told them about it. ______ T F

18. In the kinds of work I do, it is expected that people will stay for at least a year. __ T F

19. My top wage in the last five years was less than $1.25 an hour. ______ T F

20. I have earned my living for longer than a year at fulltime civilian work. ______ T F

21. I have had to stay in a mental hospital for more than one year at a time. ______ T F

22. Within the last five years I have spent more than half of the time in a mental hospital. ______ T F

23. In my teens I was regular member of a club or organization that had a grown-up who came to meetings. (Scouts, school club, 4H, church youth club, etc.) ______ T F

24. In my teens there was more than one girl with whom I had more than two dates. ______ T F

Note: The key is indicated by the underlined responses. A higher score means a better premorbid adjustment.

APPENDIX C

COMPLETE INSTRUCTIONS FOR ALL TASKS
IN THE MAIN STUDY

GENERAL ORIENTATION

THIS IS A STUDY OF PERCEPTION, A STUDY OF THE WAYS IN WHICH WE EXPERIENCE THE WORLD OF SHAPES AND SOUNDS AROUND US. THROUGHOUT THE STUDY I WILL EXPLAIN EVERYTHING YOU ARE TO DO. EACH TASK WILL BE DESCRIBED FULLY. YOU WILL BE ABLE TO PRACTICE MOST OF THE TASKS. YOU WILL BE ABLE TO ASK QUESTIONS ABOUT WHAT YOU ARE TO DO. WE WILL TAKE REST BREAKS DURING THE SESSION SO THAT YOU WON'T GET TIRED.

FIRST I WOULD LIKE TO CHECK YOUR VISION.

* ask if they have their glasses or contacts*

* Eye Test*

TAP-CLICK TIMING TASK

THIS IS THE FIRST TASK. YOU WILL HEAR A SERIES OF REGULAR CLICKS LIKE THIS (example on at .5 sec. inter-click interval). YOUR TASK IS TO TAP THIS KEY (show key and tap response to subject) SO THAT YOUR TAPS COINCIDE AS CLOSELY AS POSSIBLE WITH THE CLICKS.

FIRST I'LL SHOW YOU. (use .5 sec. interclick interval). JUST LISTEN TO THE BEAT AS LONG AS YOU WISH. ONCE YOU HAVE THE FEEL OF THE TEMPO BEGIN TO TAP IN TIME WITH THE CLICKS UNTIL I ASK YOU TO STOP. TRY TO SYNCHRONIZE YOUR TAPS WITH THE CLICKS. NOW YOU TRY IT.

DO YOU HAVE ANY QUESTIONS?

<u>One second intervals</u> -

YOU'RE DOING FINE. NOW LET'S TRY IT AGAIN. THIS TIME THE CLICKS WILL BEAT AT A SOMEWHAT SLOWER TEMPO. JUST LISTEN TO THE BEAT UNTIL YOU HAVE THE FEEL OF THE TEMPO. THEN, TAP THE KEY IN TIME WITH THE CLICKS UNTIL I ASK YOU TO STOP. (Give subject test at 1 sec. interclick interval.)

<u>Two second intervals</u> -

YOU'RE DOING FINE. NOW LET'S TRY ANOTHER SERIES OF CLICKS. THIS TIME THE BEAT WILL BE EVEN SLOWER. JUST LISTEN TO THE BEAT UNTIL YOU HAVE THE FEEL OF THE TEMPO. THEN, TAP THE KEY IN TIME WITH THE CLICKS UNTIL I ASK YOU TO STOP. (Give subject test at 2 sec. interclick interval.)

<u>Three second intervals</u> -

YOU'RE DOING FINE. NOW LET'S TRY ANOTHER SERIES OF CLICKS. THIS TIME THE BEAT WILL BE EVEN SLOWER THAN BEFORE. JUST LISTEN TO THE BEAT UNTIL YOU HAVE THE FEEL OF THE TEMPO. THEN, TAP THE KEY IN TIME WITH THE CLICKS UNTIL I ASK YOU TO STOP. (Give subject test at 3 sec. interclick interval.)

WE HAVE NOW FINISHED THIS TASK.

GENERAL INSTRUCTIONS FOR BOTH SELECTIVE ATTENTION AND SPAN OF APPREHENSION TASKS

DURING THIS TASK DISPLAYS OF LETTERS WILL APPEAR BRIEFLY ON THE SCREEN IN FRONT OF YOU. EACH DISPLAY WILL HAVE 8 LETTERS. THE CROSSES SHOW (GD 1) THE PLACES WHERE THE 8 LETTERS CAN APPEAR. YOU WON'T BE ABLE TO TELL WHICH OF THESE PLACES THE 8 LETTERS WILL APPEAR IN BEFOREHAND. BUT LETTERS WILL NEVER APPEAR BESIDES SOME OF THE PLACES WHERE YOU SEE THE CROSSES. THE FIVE VOWELS (GD 2) A E I O AND U WILL NEVER APPEAR DURING THE TASK. LETTERS WILL BE SELECTED FROM FOLLOWING LETTERS (GD 3) B C D F G H J K L M N P Q R S T AND (GD 4) V W X Y AND Z. SO EACH DISPLAY WILL BE MADE UP OF 8 DIFFERENT LETTERS SELECTED FROM THE LETTERS OF THE ALPHABET OTHER THAN THE VOWELS A E I O AND U.

LET'S REVIEW WHAT I'VE JUST SAID:

- DISPLAYS OF 8 DIFFERENT LETTERS WILL APPEAR BRIEFLY ON THE SCREEN IN FRONT OF YOU.
- YOU WON'T BE ABLE TO TELL EXACTLY WHERE THESE 8 LETTERS WILL APPEAR.
- YOU WON'T BE ABLE TO TELL WHICH 8 LETTERS WILL APPEAR.
- THE FIVE VOWELS A E I O AND U WILL NEVER APPEAR.

SELECTIVE ATTENTION TASK

NOW LET'S LOOK AT AN EXAMPLE OF A DISPLAY OF LETTERS (DD A) (5 sec).

DETECTION:

IN THIS TASK ONE AND ONLY ONE OF THE 8 LETTERS THAT APPEAR IN EACH DISPLAY WILL BE EITHER A T (DD 1) OR AN F (DD 2). WHEN EACH DISPLAY OF LETTERS APPEARS ON THE SCREEN I WANT YOU TO DISCOVER WHICH OF THE TWO TARGET LETTERS, T OR F, IS PRESENT IN THAT LETTER DISPLAY. WE ARE NOT INTERESTED IN HOW WELL YOU CAN SEE THE OTHER IRRELEVANT LETTERS THAT ACCOMPANY THE T OR F. SIMPLY FOCUS YOUR ATTENTION ON WHETHER A T OR F IS PRESENT IN THE LETTER DISPLAY. THEN, TELL ME YOUR ANSWER.

HALF OF THE TIME THE LETTER DISPLAY WILL CONTAIN A T. HALF OF THE TIME THE LETTER DISPLAY WILL CONTAIN AN F. THERE IS NO WAY YOU CAN TELL BEFORE YOU SEE EACH LETTER DISPLAY WHETHER A T OR AN F BE PRESENT IN THAT DISPLAY.

WHEN EACH LETTER DISPLAY APPEARS THE T OR F MAY APPEAR IN ANY OF THE POSSIBLE POSITIONS ON THE SCREEN.

LET'S SEE HOW THIS WILL WORK. A DISPLAY OF 8 LETTERS WILL APPEAR ON THE SCREEN. FOCUS YOUR ATTENTION ON WHETHER A T OR AN F IS PRESENT IN THE DISPLAY. THEN, TELL ME YOUR CHOICE AS SOON AS THE DISPLAY OF LETTERS HAS DISAPPEARED. IF YOU'RE NOT SURE GIVE YOUR BEST GUESS.

READY (DD 11, 5 sec.). IN THE EXAMPLE YOU SAW F WAS THE CORRECT CHOICE (display on). AS YOU SEE F WAS PRESENT IN THE LETTER DISPLAY WHILE T WAS NOT INCLUDED.

LET'S TRY IT AGAIN. READY (DD 12, 5 sec.). IN THE EXAMPLE YOU SAW T WAS THE CORRECT CHOICE (display on). AS YOU SEE T WAS PRESENT IN THE LETTER DISPLAY WHILE F WAS NOT INCLUDED.

LET'S TRY ANOTHER TIME. THIS TIME THE DISPLAY OF LETTER'S WON'T APPEAR AS LONG. READY (DD 3, 5 sec.). IN THE EXAMPLE YOU SAW F WAS THE CORRECT CHOICE (display on). AS YOU SEE F WAS PRESENT IN THE LETTER DISPLAY WHILE T WAS NOT INCLUDED.

HERE'S ANOTHER EXAMPLE. READY (DD 4, 15 sec.). IN THE EXAMPLE YOU SAW F WAS THE CORRECT CHOICE (display on). AS YOU SEE F WAS PRESENT IN THE LETTER DISPLAY WHILE T WAS NOT INCLUDED.

FOR THE REST OF THIS TASK THE LETTER DISPLAYS WILL APPEAR VERY BRIEFLY. WHEN I SAY "READY" FOCUS ON THE DOT IN FRONT OF YOU UNTIL THE LETTER DISPLAY APPEARS. THEN FOCUS YOUR ATTENTION ON WHETHER A T OR AN F IS PRESENT IN THE DISPLAY AND TELL ME YOUR CHOICE.

READY (DD 15, 50 sec.). IN THE EXAMPLE YOU SAW T WAS THE CORRECT CHOICE (display on). AS YOU SEE T WAS PRESENT IN THE LETTER DISPLAY WHILE F WAS NOT INCLUDED.

HERE'S ANOTHER EXAMPLE. READY (DD 16, 50 sec.). IN THE EXAMPLE YOU SAW F WAS THE CORRECT CHOICE (display on). AS YOU SEE F WAS PRESENT IN THE LETTER DISPLAY WHILE T WAS NOT INCLUDED.

Give tone-control instructions here.

SUMMARY:

PLEASE FOCUS ON THE DOT WHEN YOU SAY YOU'RE READY. CONTINUE TO FOCUS ON THE DOT UNTIL THE LETTER DISPLAY APPEARS. WHEN THE LETTER DISPLAY APPEARS SIMPLY FOCUS YOUR ATTENTION ON WHETHER A T OR AN F IS PRESENT IN THE LETTER DISPLAY AND TELL ME YOUR ANSWER. IF YOU'RE NOT SURE PLEASE GIVE YOUR BEST GUESS.

LET'S TRY OUT THE PROCEDURE (use DD 17) (use DD 18) (give no feedback) (2 ITU use PI 3.8 and 2.2) (5 ITU use PI 1.6 and 4.6).

NOW WE WILL GO THROUGH SOME PRACTICE WARM-UP TRIALS. YOU WILL NOT BE TOLD IN ANY OF THE PRACTICE OR TEST TRAILS AS TO WHETHER YOUR CHOICES ARE CORRECT OR NOT. DO YOU HAVE ANY QUESTIONS?

O.K. LET'S BEGIN THE PRACTICE TRIALS. PLEASE TRY TO DO YOUR BEST. IF THE LETTER DISPLAY FAILS TO APPEAR PLEASE LET ME KNOW.

* After 16 practice trials * -

NOW WE'LL DO THE TEST TRIALS.

SPAN OF APPREHENSION TASK

NOW LET'S LOOK AT AN EXAMPLE OF A DISPLAY OF LETTERS (FD A) (5 sec.).

SPAN:

WHEN EACH DISPLAY OF LETTERS APPEARS I WANT YOU TO TRY TO SEE AND REMEMBER AS MANY OF THE LETTERS AS YOU CAN.

POST-STIMULUS RECOGNITION:

AFTER EACH DISPLAY OF LETTERS HAS DISAPPEARED, TWO LETTERS WILL APPEAR BELOW THE SCREEN LIKE THIS (Z AND P manual on). AFTER EACH DISPLAY OF LETTERS DISAPPEARS FROM THE SCREEN YOU ARE TO CHOOSE WHICH OF THE TWO LETTERS THAT APPEARS BELOW THE SCREEN IS THE LETTER THAT WAS PRESENT IN THE LETTER DISPLAY YOU SAW ON THE SCREEN. THEN, TELL ME YOUR ANSWER.

SHAPING:

LET'S SEE HOW THIS WILL WORK. FIRST A DISPLAY OF 8 LETTERS WILL APPEAR ON THE SCREEN. TRY TO SEE AND REMEMBER AS MANY OF THE 8 LETTERS AS YOU CAN. THEN, A FEW SECONDS LATER, TWO LETTERS WILL APPEAR BELOW THE SCREEN. SELECT WHICH OF THESE TWO LETTERS WAS PRESENT IN THE 8 LETTERS YOU SAW ON THE SCREEN. TELL ME YOUR ANSWER. IF YOU'RE NOT SURE GIVE YOUR BEST GUESS.

READY (FD 1, 5 sec., alt. X and J). IN THE EXAMPLE YOU SAW X WAS THE CORRECT CHOICE (display on, choices on). AS YOU SEE THE LETTERS P H K X W G Y AND L WERE PRESENT IN THE LETTER DISPLAY. X WAS THE CORRECT CHOICE SINCE X WAS PRESENT IN THE LETTER DISPLAYS WHILE J WAS NOT INCLUDED.

LET'S TRY IT AGAIN. READY (FD 2, 5 sec., alt. W and N). IN THE EXAMPLE YOU SAW W WAS THE CORRECT CHOICE (display on, choices on). AS YOU SEE THE LETTER J X P G W F L AND D WERE PRESENT IN THE LETTER DISPLAY. W WAS THE CORRECT CHOICE SINCE W WAS PRESENT IN THE LETTER DISPLAY WHILE N WAS NOT INCLUDED.

LET'S TRY ANOTHER TIME. THIS TIME THE DISPLAY OF LETTERS WON'T APPEAR AS LONG. READY (FD 3, 5 sec., alt. P and R). IN THE EXAMPLE YOU SAW P WAS THE CORRECT CHOICE (display on, choices on). AS YOU SEE THE LETTERS L K F P X J C AND G WERE PRESENT IN THE LETTER DISPLAY. P WAS THE CORRECT CHOICE SINCE P WAS PRESENT IN THE LETTER DISPLAY WHILE R WAS NOT INCLUDED.

HERE'S ANOTHER EXAMPLE. READY (FD 4, 5 sec., alt. V and T). IN THE EXAMPLE YOU SAW V WAS THE CORRECT CHOICE (display on, choices on). AS YOU SEE THE LETTERS P W S N L K J AND V WERE PRESENT IN THE LETTER DISPLAY. V WAS THE CORRECT CHOICE SINCE V WAS PRESENT IN THE LETTER DISPLAY WHILE T WAS NOT INCLUDED.

FOR THE REST OF THIS TASK THE LETTER DISPLAYS WILL APPEAR VERY BRIEFLY. WHEN I SAY "READY" FOCUS ON THE DOT

IN FRONT OF YOU UNTIL THE LETTER DISPLAY APPEARS. THEN TRY TO SEE AND REMEMBER AS MANY LETTERS AS YOU CAN. SELECT WHICH OF THE TWO ALTERNATIVES THAT APPEARS AFTERWARDS WAS PRESENT IN THE LETTER DISPLAY AND TELL ME YOUR CHOICE.

READY (FD 5, 50 msec., alt. B and D). IN THE EXAMPLE YOU SAW B WAS THE CORRECT CHOICE (display on, choices on). AS YOU SEE THE LETTERS B M H P F V W AND R WERE PRESENT IN THE LETTER DISPLAY. B WAS THE CORRECT CHOICE SINCE B WAS PRESENT IN THE LETTER DISPLAY WHILE D WAS NOT INCLUDED.

HERE'S ANOTHER EXAMPLE. READY (FD 6, 50 msec., alt. Z and N). IN THE EXAMPLE YOU SAW Z WAS THE CORRECT CHOICE (display on, choices on). AS YOU SEE THE LETTERS P H C Z T V K AND F WERE PRESENT IN THE LETTER DISPLAY. Z WAS THE CORRECT CHOICE SINCE Z WAS PRESENT IN THE LETTER DISPLAY WHILE N WAS NOT INCLUDED.

Give tone-control instructions here.

SUMMARY:

PLEASE FOCUS ON THE DOT WHEN (ITU - YOU SAY YOU'RE READY) (SELF-INITIATE - I SAY READY). CONTINUE TO FOCUS ON THE DOT UNTIL THE LETTER DISPLAY APPEARS. WHEN THE LETTER DISPLAY APPEARS TRY TO SEE AND REMEMBER AS MANY OF THE LETTERS AS YOU CAN. THEN, SELECT WHICH OF THE TWO LETTERS THAT APPEARS AFTERWARDS, BELOW THE SCREEN, WAS THE ONE PRESENT IN THE LETTER DISPLAY AND TELL ME YOUR ANSWER. PLEASE, KEEP LOOKING AT THE SCREEN UNTIL THE TWO LETTERS YOU ARE TO SELECT FROM APPEAR BELOW THE SCREEN. IF YOU'RE NOT SURE WHICH IS THE CORRECT LETTER PLEASE GIVE YOUR BEST GUESS.

LET'S TRY OUT THE PROCEDURE (use FD 7, alt. R and C) (use FD 8, alt. F and Y) (give no feedback) (2 ITU use PI 3.8 and 2.0) (5 ITU use PI 2.6 and 5.2).

NOW WE WILL GO THROUGH SOME PRACTICE WARM-UP TRIALS. I WILL NOT BE ABLE TO TELL YOU IN ANY OF THE PRACTICE OR TEXT TRIALS AS TO WHETHER YOUR CHOICES ARE CORRECT OR NOT. DO YOU HAVE ANY QUESTIONS?

O.K. LET'S BEGIN THE PRACTICE TRIALS. PLEASE TRY TO DO YOUR BEST. IF THE LETTER DISPLAY FAILS TO APPEAR PLEASE LET ME KNOW.

* After 16 practice trials * -

NOW WE'LL DO THE TEST TRIALS.

TONE-CONTROL INSTRUCTIONS

BEFORE YOU SEE EACH LETTER DISPLAY I'LL SAY "READY", THEN YOU TELL ME WHEN YOU'RE READY. YOU WILL THEN HEAR A SHORT TONE (demonstrate) WHICH IS THE SIGNAL FOR THE APPEARANCE OR THE LETTER DISPLAY.

O ITU THE LETTER DISPLAY WILL APPEAR A SHORT TIME AFTER THE TONE. THE LETTER DISPLAY WILL ALWAYS APPEAR EXACTLY THE SAME AMOUNT OF TIME AFTER THE TONE. I'LL SHOW YOU. (demonstrate twice, use DD 16.) SO YOU'-LL BE ABLE TO TELL WHEN TO EXPECT THE APPEARANCE OF THE LETTER DISPLAY AFTER THE TONE SOUNDS.

2 ITU THE LETTER DISPLAY WILL APPEAR ANYTIME BETWEEN THIS LONG AFTER THE TONE (2.0 sec.) AND THIS LONG AFTER THE TONE (4.0 sec.). (demonstrate twice, use DD 16) (Say "I'll show you again" for the second demonstration.) SO YOU'LL BE ABLE TO TELL WHEN TO EXPECT THE APPEARANCE OF THE LETTER DISPLAY AS APPEARING SOMETIME WITHIN THE LIMITS I'VE SHOWN YOU.

5 ITU THE LETTER DISPLAY WILL APPEAR ANYTIME BETWEEN THIS LONG AFTER THE TONE (0.5 sec.) AND THIS LONG AFTER THE TONE (5.5 sec.). (demonstrate twice, use DD 16) (Say "I'll show you again" for the second demonstration.) SO YOU'LL BE ABLE TO TELL WHEN TO EXPECT THE APPEARANCE OF THE LETTER DISPLAY AS APPEARING SOMETIME WITHIN THE LIMITS I'VE SHOWN YOU.

S.I. THE LETTER DISPLAY WILL APPEAR WHEN YOU PRESS THE

BUTTON. PRESS THE BUTTON WHENEVER YOU FEEL READY. MAKE SURE TO RELEASE THE BUTTON AFTER YOU PRESS IT. LET'S TRY IT. LET'S TRY IT AGAIN. (demonstrate twice, use DD 16) AS YOU CAN SEE YOU'LL BE THE PERSON WHO INITIATES THE FLASH OF LETTERS. (set timer at 0.1 sec.).

BETWEEN TASK INSTRUCTIONS

NOW WE'RE GOING TO DO THE NEXT TASK. ALTHOUGH THE NEXT TASK WILL BE SIMILAR TO THE PREVIOUS ONE IN SOME WAYS, IT WILL BE VERY DIFFERENT IN MANY OTHER WAYS. I WANT YOU JUST TO FORGET ABOUT WHAT WE DID IN THE PREVIOUS TASK. FOR THIS NEXT TASK WE'LL START OVER FROM THE BEGINNING EXPLAINING WHAT YOU ARE TO DO JUST AS IF YOU NEVER DID THE LAST TASK. SO LISTEN CAREFULLY AND DON'T EXPECT EVERYTHING TO BE THE SAME AS IT WAS BEFORE EVEN THROUGH SOME OF THE INSTRUCTIONS WILL BE VERY SIMILAR.

APPENDIX D

ANALYSIS OF VARIANCE FOR THE PERCEPTUAL EXPERIMENT
OF THE MAIN STUDY USING THE NUMBER OF RESPONSES CORRECT

Source	df	SS	MS	F
Between Subjects				
A (Subject Group)	2	3888.76	1944.38	39.59*
B (ITU and Self-Initiate)	3	35.69	11.90	0.24
C (Order)	1	44.08	44.08	0.90
A x B	6	258.41	43.07	0.88
A x C	2	155.39	77.70	1.58
B x C	3	348.96	116.32	2.37
A x B x C	6	418.19	69.70	1.42
Subjects Within Groups	72	3536.00	49.11	
Total	95	8685.48		
Within Subjects				
D (Attention vs. Span)	1	4941.02	4941.02	244.48*
A x D	2	28.33	14.17	0.70
B x D	3	40.44	13.48	0.67
C x D	1	10.09	10.09	0.50
A x B x D	6	131.58	21.93	1.09
A x C x D	2	63.19	31.60	1.56
B x C x D	3	142.70	47.57	2.35
A x B x C x D	6	34.65	5.78	0.29
D x Subjects Within Groups	72	1455.00	20.21	
Total	96	6847.00		

*$p < .001$

APPENDIX E

ANALYSIS OF VARIANCE FOR THE
PERCEPTUAL EXPERIMENT OF THE MAIN STUDY
USING THE ARCSIN TRANSFORMATION OF THE PROPORTION CORRECT

Source	df	SS	MS	F
Between Subjects				
A (Subject Group)	2	5.3266	2.6633	40.72**
B (ITU and Self-Initiate)	3	.0340	.0113	0.17
C (Order)	1	.0804	.0804	1.23
A x B	6	.3686	.0614	0.94
A x C	2	.2767	.1384	2.12
B x C	3	.5365	.1788	2.73
A x B x C	6	.5783	.0964	1.47
Subjects Within Groups	72	4.7086	.0654	
Total	95	11.9097		
Within Subjects				
D (Attention vs. Span)	1	7.1026	7.1026	244.12**
A x D	2	.1567	.0784	2.69
B x D	3	.0463	.0154	0.53
C x D	1	.0224	.0224	0.77
A x B x D	6	.1991	.0332	1.14
A x C x D	2	.1134	.0567	1.95
B x C x D	3	.2584	.0861	2.96*
A x B x C x D	6	.0665	.0111	0.38
D x Subjects with Groups	72	2.0948	.0291	
Total	96	10.0602		

*$p < .05$

**$p < .001$

APPENDIX F

TABLE OF MEANS AND STANDARD DEVIATIONS
OF ATTENTION TASK AND SPAN TASK SCORES FOR THE
THREE SUBJECT GROUPS USING THE NUMBER OF RESPONSES CORRECT

	Schizophrenics[a]	Psychiatric Controls[a]	Students[a]
Attention Task			
Mean	44.28	51.06	55.97
SD	7.45	7.12	5.83
Span Task			
Mean	35.19	40.16	45.53
SD	5.61	5.12	4.19

[a] n = 32 for each group.

APPENDIX G

ANALYSIS OF VARIANCE FOR THE TAP-CLICK TIMING EXPERIMENT OF THE MAIN STUDY USING THE SIGNED ERROR DEVIATION SCORES

Source	df[a]	SS	MS	F
Between Subjects				
A (Subject Group)	2	5.2731	2.6365	10.40*
Subjects Within Groups	93	23.5834	.2536	
Total Between	95	28.8565		
Within Subjects				
B (Interclick Interval)	2(1)	.6771	.3386	2.87
A x B	4(2)	2.1934	.5484	4.65[b]
B x Subjects Within Groups	186(93)	21.9160	.1178	
C (Trials)	9(1)	.3791	.0421	2.52[c]
A x C	18(2)	.4071	.0226	1.35
C x Subjects Within Groups	837(93)	13.9805	.0167	
B x C	18(1)	.5605	.0311	1.66[d]
A x B x C	36(2)	.7532	.0209	1.12
B x C x Subjects Within Groups	1674(93)	31.3279	.0187	
Total Within	2784	72.1948		

[a]Degrees of freedom in parentheses are for the conservative test.

[b]$p < .005$ nonconservative test, $p < .05$ conservative test.

[c]$p < .01$ nonconservative test, $p = .25$ conservative test.

[d]$p < .05$ nonconservative test, $p = .25$ conservative test.

*$p < .001$.

APPENDIX H

TABLE OF MEANS AND STANDARD DEVIATIONS OF TAP-CLICK SIGNED ERROR DEVIATION SCORES AT THE THREE INTERCLICK INTERVAL CONDITIONS FOR THE THREE SUBJECT GROUPS

Interclick Interval	Schizophrenics[a]	Psychiatric Controls[a]	Students[a]
One Second			
Mean	+.0093	-.0185	-.0001
SD[b]	.0294	.0035	.0006
Two Seconds			
Mean	+.0965	+.0080	-.0066
SD[b]	.0286	.0065	.0009
Three Seconds			
Mean	+.1300	-.0204	-.0352
SD[b]	.0592	.0128	.0052

[a] n = 32 for each group.

[b] The standard deviations were calculated using the mean signed error deviation averaged over the ten test trials within each subject.

APPENDIX I

ANALYSIS OF VARIANCE FOR THE TAP-CLICK TIMING EXPERIMENT OF THE MAIN STUDY USING THE VARIABLE ERROR SCORES

Source	df[a]	SS	MS	F
Between Subjects				
A (Subject Group)	2	.0161	.0081	1.48
Subjects Within Groups	93	.5047	.0054	
Total Between	95	.5208		
Within Subjects				
B (Interclick Interval)	2(1)	.7439	.3719	95.16*
A x B	4(2)	.0089	.0022	0.57
B x Subjects Within Groups	186(93)	.7270	.0039	
Total Within	192	1.4798		

[a]Degrees of freedom in parantheses are for the conservative test.

*$p < .001$ conservative test.

APPENDIX J

TABLE OF MEANS AND STANDARD DEVIATIONS
OF TAP-CLICK VARIABLE ERROR SCORES AT THE
THREE INTERCLICK INTERVAL CONDITIONS FOR THE THREE SUBJECT GROUPS

Interclick Interval	Schizophrenics[a]	Psychiatric Controls[a]	Students[a]
One Second			
Mean	.0573	.0549	.0353
SD	.0016	.0044	.0002
Two Seconds			
Mean	.1043	.1050	.0836
SD	.0035	.0013	.0012
Three Seconds			
Mean	.1831	.1636	.1714
SD	.0189	.0046	.0041

[a] n = 32 for each group.

APPENDIX K

CORRELATIONS OF AGE AND EDUCATION WITH TAP-CLICK ERROR SCORES FOR THE THREE SUBJECT GROUPS

CORRELATIONS OF AGE AND EDUCATION WITH
TAP-CLICK ERROR SCORES FOR THE THREE SUBJECT GROUPS

Error Measure	Interclick Interval In Sec	Schizophrenics[a]		Psychiatric Controls[a]		Students[a]	
		Age	Education	Age	Education	Age	Education
Variable error scores	1	-.15	-.08	-.17	+.03	-.03	-.14
	2	+.18	+.06	-.03	+.29	+.19	+.06
	3	.00	.00	-.02	+.17	+.13	-.17
Mean signed error deviation scores. (constant error)	1	-.01	-.03	+.03	-.03	-.11	-.14
	2	+.04	-.21	-.06	+.05	+.06	+.18
	3	+.11	-.23	-.15	+.17	+.02	.00
Absolute value of constant error	1	+.08	-.32	-.06	-.10	-.04	-.17
	2	+.01	-.24	-.23	+.12	-.17	.00
	3	-.02	-.27	-.05	-.09	-.08	+.22

Note: None of the correlations were statistically significant at the $p < .05$ level two-tailed.

[a] n = 32 for each group.

APPENDIX L

CORRELATIONS OF ATTENTION SCORES AND SPAN SCORES WITH TAP-CLICK ERROR SCORES FOR THE THREE SUBJECT GROUPS

CORRELATIONS OF ATTENTION SCORES AND SPAN SCORES
WITH TAP-CLICK ERROR SCORES FOR THE THREE SUBJECT GROUPS

Error Measure	Interclick Interval In Sec	Schizophrenics[a]		Psychiatric Controls[a]		Students[a]	
		Attention	Span	Attention	Span	Attention	Span
Variable Error Scores	1	-.27	-.43**	+.10	-.30*	-.18	.00
	2	-.17	-.24	-.18	-.11	-.30*	-.11
	3	-.19	+.08	-.08	+.02	+.23	-.12
Mean Signed Error Deviation Scores (Constant Error)	1	+.27	-.15	+.12	-.04	-.10	-.24
	2	-.04	+.01	-.25	-.17	-.28	+.04
	3	-.02	-.12	-.24	+.11	-.32*	-.07
Absolute Value of Constant Error	1	-.07	-.05	-.20	+.23	-.10	+.19
	2	-.11	-.06	+.03	-.08	+.01	+.12
	3	-.19	-.16	+.26	+.04	+.30	+.22

*$p < .05$ one-tailed.

**$p < .01$ one-tailed.

[a] $n = 32$ for each group.